

**UNITED STATES AIR FORCE  
RESEARCH LABORATORY**



**ACCOMMODATION AND OCCUPATIONAL  
SAFETY FOR PREGNANT MILITARY PERSONNEL**

**Teresa Crase Perkins  
Sherri U. Blackwell**

**SYTRONICS, INC.  
4433 DAYTON-XENIA ROAD BLDG 1  
DAYTON, OH 45432**

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**Human Effectiveness Directorate  
Crew System Interface Division  
2255 H Street  
Wright-Patterson AFB OH 45433-7022**

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### FOR THE COMMANDER



HENDRICK W. RUCK, PhD  
Chief, Crew System Interface Division  
Air Force Research Laboratory

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## PREFACE

The research activities of the Accommodation and Occupational Safety for Pregnant Military Personnel project were conducted by Sytronics, Inc. through U.S. Army Medical Research and Materiel Command Grant DAMD17-96-1-6311. Government resources (traditional anthropometric tools and whole-body scanner) were used extensively in performing the required research. These resources are the property of the *Computerized Anthropometric Research and Design (CARD)* Laboratory of the Crew System Interface Division, Human Effectiveness Directorate, *Air Force Research Laboratory (AFRL)* at Wright-Patterson Air Force Base, Ohio. Access to these resources was gained through *United States Air Force (USAF) Cooperative Research and Development Agreement (CRDA)* 97-066-AL-01. Ms. Sacelia Heller (MCMR-AAA-A) was the government point of contact for the research grant and Ms. Kathleen Robinette (AFRL/HECP) for the CRDA.

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## INTRODUCTION

The "*Accommodation and Occupational Safety for Pregnant Military Personnel*" Study (commonly referred to as the *Pregnant Women's Study (PWS)*) is a research program performed by Sytronics, Inc. in cooperation with the USAF 74<sup>th</sup> Medical Group, and the Air Force Research Laboratory's (AFRL) Computerized Anthropometric Research and Design (CARD) Laboratory, under research grant DAMD17-96-1-6311 from the U.S. Army Medical Research and Materiel Command, and Air Force CRDA 97-066-AL-01. The purpose of this study was to collect a set of traditional anthropometric data and a *three-dimensional (3-D)* whole-body scan data set for a sample population of pregnant women.

The study objectives were: to characterize size and shape changes for a sample population of pregnant women, and to provide recommendations for future research to evaluate the occupational constraints placed on pregnant women due to their changing body size and physical capabilities.

## BACKGROUND

The number of women working today has increased more than tenfold since World War II (Chavkin, 1986). It is estimated that about 85% of the female labor force will become pregnant at some point during their career (Chavkin, 1986). Therefore, pregnant women are a significant portion of the workforce, and more than 75% of those pregnant for the first time continue working into their third trimester (Nicholls and Grieve, 1992).

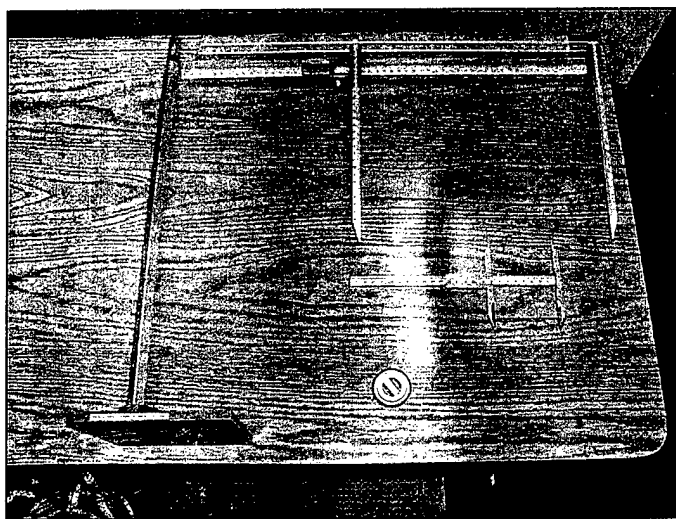
The military no longer considers pregnancy a basis for automatic discharge, so there are increasing numbers of women in the military. Because of revised regulations, women are expected to perform their assigned tasks during pregnancy. At the onset of pregnancy, many active-duty women may be exposed to a number of occupational high-risk factors--lifting heavy objects (up to 45 pounds) or working in confined spaces (for example, in tanks or underground). Their duties may also entail prolonged bending, stooping, twisting, standing, or sitting.

Until recently, little attention has been given to the accommodation and safety of pregnant military women. In fact, there are no guidelines that address physical accommodation requirements for pregnant, active-duty military women. The rising number of military women has created a need for research on the occupational limits imposed by a pregnant woman's increasing body size and reach constraints. To date, no significant data collections provide 3-D anthropometric measurement of shape changes during pregnancy. A 3-D data set that clearly identifies a woman's shape changes during pregnancy will help designers and policy-makers define and improve the work environment for pregnant women.

## METHOD

### Equipment

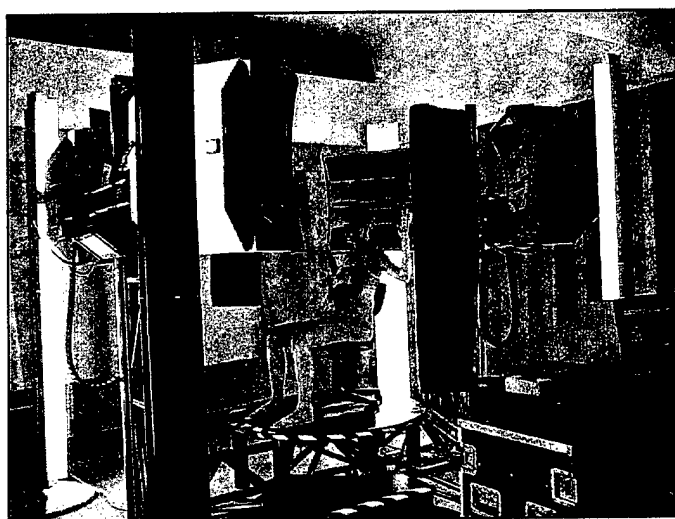
Traditional anthropometric data were collected using standard anthropometric tools such as tape measures, sliding calipers, and anthropometers (see Figure 1). The traditional anthropometric data provide the *size* change associated with pregnancy.



**Figure 1. Traditional Anthropometric Tools: Tape Measure, Sliding Caliper, and Anthropometer.**

The Cyberware WB4 whole-body scanner was used to scan the subjects. Figure 2 shows a subject being scanned by the Cyberware WB4 whole-body scanner. The

Cyberware WB4 whole-body scanner is a 3-D digitizer used to capture surface shape and color information on the human body as a single entity. The lasers in the scanner heads create a low-power, horizontal plane-of-light, which shines on the surface of the subject. The light reflects the contour images of the subject through a series of mirrors and prisms to cameras, which digitize the image. The scanner can cover a volume of 2 m high and 1.2 m in diameter. One scan takes less than 20 seconds which helps to minimize errors due to movement and swaying. The WB4 whole-body scanner has a resolution of 2 mm vertically and 2.5 mm horizontally. Therefore, the longest distance to any digitized point in the scanning space is  $\pm 2.16$  mm. The 3-D anthropometric data provide the *shape* changes undergone during pregnancy.



**Figure 2. Cyberware Whole-Body Laser Scanner.**

### Subjects

Since the target population identified for the "Accommodation and Occupational Safety for Pregnant Military Personnel" study includes a proportional representation of the tri-service female military population, subject recruitment efforts were focused on the Wright-Patterson Regional Medical Center--Obstetrics and Gynecology Flight, Wright-Patterson Air Force Base, Ohio. The goal was to collect traditional anthropometric data, demographic data, occupational information, and 3-D anthropometric data on a sample population of approximately 25 females.

Due to the possibility of pregnant military women departing the military service, relocating to a different geographical area, experiencing medical complications, not carrying the baby to full-term, or electing to drop out of the study, it deemed necessary to begin the study with 50 females, if possible, in order to obtain an end sample size of approximately 25 females.

The subject recruitment efforts were focused on the Wright-Patterson Regional Medical Center--Obstetrics and Gynecology Flight, Wright-Patterson Air Force Base, Ohio. Ms. Teresa Crase and Ms. Sherri Blackwell attended weekly orientation meetings for pregnant women, which were held at Wright-Patterson Regional Medical Center in the Dental Clinic Conference Room. On the average, 15 pregnant women attended each weekly meeting. During these meetings, Ms. Crase and Ms. Blackwell briefly described the study and invited pregnant women to participate. Interested participants signed up for the study and their questions were answered.

In order to be accepted into the study, the subject had to meet several qualifications.

- Between 18-40 years of age
- In their first trimester (before any noticeable weight and/or body changes occurred)
- Active-duty military

The small number of available active-duty subjects, however, required that the sample be augmented with civilian women who met the U.S. Air Force and U.S. Navy military height/weight entrance requirements before they became pregnant. The military height/weight requirement chart used to determine qualification for participation in this study is included in Table 1.

Because subject recruitment proved more difficult than expected, subject recruiting efforts were expanded to include two local doctors' offices.

In order to reach as many potential subjects as possible, several forms of advertisement were used. To help advertise for the study, a brochure was printed (Appendix A). Brochures were distributed to women at the weekly orientation meetings at the Medical Center, and to pregnant women at the local doctors' offices. Brochures

**Table 1. Military Height/Weight Requirement Chart.**  
*(Used for the Accommodation and Occupational Safety for  
Pregnant Military Personnel Study)*

**U.S. AIR FORCE AND U.S. NAVY  
HEIGHT/WEIGHT REQUIREMENTS FOR AVIATORS**

*Female*

STATURE (in)	58.0	59.0	60.0	61.0	62.0	63.0	64.0
STATURE (cm)	147.3	149.9	152.4	154.9	157.5	160.0	162.6
MAX WT	126.0	128.0	130.0	132.0	134.0	136.0	139.0
MIN WT	87.0	89.0	92.0	95.0	97.0	100.0	103.0

STATURE (in)	65.0	66.0	67.0	68.0	69.0	70.0	71.0
STATURE (cm)	165.1	167.6	170.2	172.7	175.3	177.8	180.3
MAX WT	144.0	148.0	152.0	156.0	161.0	165.0	169.0
MIN WT	106.0	108.0	111.0	114.0	117.0	119.0	122.0

STATURE (in)	72.0	73.0	74.0	75.0	76.0	77.0	78.0
STATURE (cm)	182.9	185.4	188.0	190.5	193.0	195.6	198.1
MAX WT	174.0	179.0	185.0	190.0	196.0	201.0	206.0
MIN WT	125.0	128.0	130.0	133.0	136.0	139.0	141.0

STATURE (in)	79.0	80.0
STATURE (cm)	200.7	203.2
MAX WT	211.0	216.0
MIN WT	144.0	147.0

were also posted at local baby focused retail stores. Two articles were published in the *Skywrighter* (Appendix B), a weekly newspaper produced and distributed at Wright-Patterson Air Force Base.

The time frame for data collection was dependent on the availability of the whole-body scanner and the length of a normal pregnancy. Because of these limitations, subject recruitment ended in May 1997, with 35 subjects enrolled.

The number of hours the subject spent at the data collection site (CARD Laboratory) and the number of miles she drove to get to the Lab were recorded at the end of each data collection session. A payroll record form which contains this information was kept for each subject (Appendix C). At the end of each month, Sytronics sent each non-military subject a check for the total time contributed to the study and reimbursement for miles driven to and from the Lab for that month. Active-duty military women were not paid for time or mileage; non-military subjects were paid \$8.00 an hour and \$.30 per mile traveled.

## Procedure

### Data Collection

Both the traditional and the 3-D anthropometric data were collected on 35 pregnant women throughout the pregnancy term. These data can contribute to on-going military research addressing human modeling for specific workstation accommodation studies in both seated and standing positions.

There were six data collection sessions per subject. The sessions were spread out over 40 weeks of pregnancy in order to capture as much size and shape change as possible. One data collection session was conducted during the first trimester, one session during the second trimester, and three sessions during the third trimester. There was also one post-delivery session. Most abdominal change occurred in the third trimester, therefore, half of the data was collected during this period of gestation.

The first session, or baseline session, was completed prior to noticeable weight and body changes and/or by the end of the first trimester. For example, one subject was measured as early as four weeks and another as late as 16 weeks for the first session. The second session was scheduled to be completed at 20 weeks; the third session, between 28-29 weeks; the fourth session, between 32-33 weeks; and the fifth session, between 37-38 weeks. Whenever possible, the sixth session, which was the post-delivery session, was completed within a month after delivery.

Subjects were scheduled for sessions as close to the pre-selected (or target) number of weeks as possible. Sometimes it was impossible to complete sessions at the

desired time due to scheduling conflicts, illness, holidays, vacations, or lack of transportation. Therefore, the earliest possible time was scheduled.

#### Demographic and Traditional Anthropometric Data

Prior to the collection of traditional anthropometry (measurement of the human body with calipers and tape measurers, Figure 1, page 2), anatomical landmarks (physical manifestations common to all humans as a species) were located and marked using an eyeliner pencil and adhesive blue dots. Figure 3 shows a subject with landmarks.

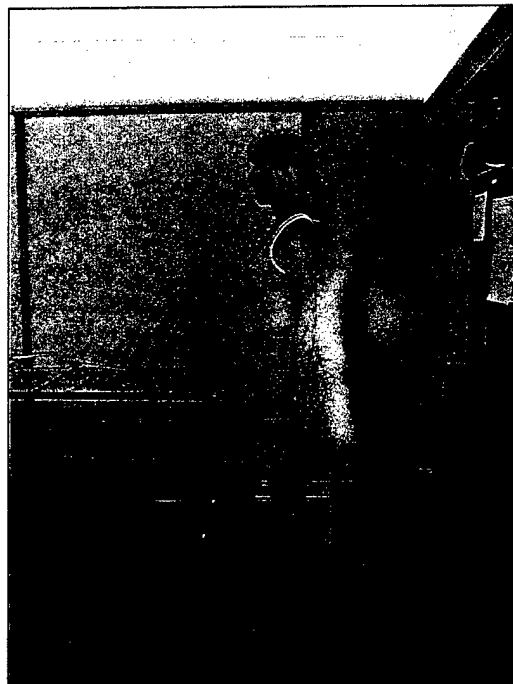
Landmarks are used as 3-D points for aligning the scan data within the same axis system. Landmarks can also be used to calculate measures such as distance, volume, surface area, and contour length. Statistical analysis of shape, or form, is done using landmarks as well. The landmark stickers used for this study were blue, 9 mm (diameter) adhesive dots. Seventy-six anatomical landmarks were placed on each subject, and Appendix D contains a complete list of the landmarks.

For most measures, the subject stood in an upright, straight posture with the heels together and toes apart. The measurer positions the subject's head in the Frankfurt Plane, with the right trignon on the same horizontal level as the lowest point of the right orbit (bony eye socket). Figure 4 shows a subject with her head positioned in the Frankfurt Plane.

For measurements on a seated subject, the measurer arranged the horizontal surfaces of seat and foot so that the thighs were horizontal, lower legs were vertical, and the feet flat on their horizontal support (Kroemer, 1989). Figure 5 shows a subject in the seated posture for traditional anthropometric data collection. Adjustable foot boxes were used to align the knee to a 90° angle as shown.

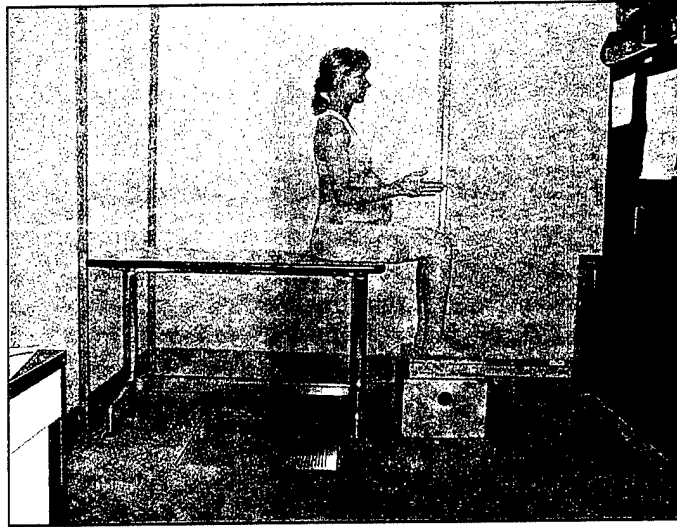


**Figure 3. Subject with Anatomical Landmarks.**



**Figure 4. Frankfurt Plane: Proper Head Position for Anthropometric Standing Posture for Data Collection.**





**Figure 5. Anthropometric Sitting Posture for Data Collection.**

A data collection sheet including the 37 measured dimensions is included in Table 2. Subjects were required to take a break every 10 minutes during the traditional anthropometric data collection process to keep them from becoming overtired by the strict posture.

Appendix D contains a list of landmarks, a list of dimensions, the landmark descriptions, the dimension descriptions, and a glossary of related terms.

#### Three-Dimensional Anthropometric Data

The 3-D data were gathered using the Cyberware laser surface whole-body scanning system. The scanning procedure involved: performing a visual inspection of the landmarks as an effort to ensure all landmarks were present, positioning the subject on the scanning platform, and finally, scanning. The standard scanning apparel for subjects consisted of light gray, biker shorts and light gray sports bras. Both the scanning shorts and bras are a blend of cotton and spandex material. This blend of material was necessary for clothing to conform to the body and capture shape without restricting the tissue and changing the appearance of the surface. Latex caps were worn to cover the hair and provide a more accurate shape of the head.

**Table 2. Anthropometric Data Form.**

**ANTHROPOMETRIC DATA FORM - PREGNANT WOMEN'S STUDY**

*(Measurement Values in cm)*

Subject No.: \_\_\_\_\_ Date: \_\_\_\_\_

Name: \_\_\_\_\_ Address: \_\_\_\_\_

Date of Birth (mm/dd/yy): \_\_\_\_\_

Age \_\_\_\_\_ Local Phone: \_\_\_\_\_ Pregnancy: \_\_\_\_\_ 1st \_\_\_\_\_ 2nd \_\_\_\_\_ Other

Race: W B H AI or AN A or PI Other: \_\_\_\_\_

*Do not write below this line*

Thumbtip Reach, R \_\_\_\_\_ Chest Depth \_\_\_\_\_

Weight \_\_\_\_\_ Chest Depth (BB) \_\_\_\_\_

Stature \_\_\_\_\_ Waist Depth, (P) \_\_\_\_\_

Waist Depth, (O) \_\_\_\_\_

Cervicale Height \_\_\_\_\_ Chest Circ. \_\_\_\_\_

Suprasternale Height \_\_\_\_\_ Chest Circ. (BB) \_\_\_\_\_

Substernale Height \_\_\_\_\_ Waist Circ. (P) \_\_\_\_\_

Chest Height \_\_\_\_\_ Waist Circ. (O) \_\_\_\_\_

Chest Height (BB) \_\_\_\_\_ Hip Circ. \_\_\_\_\_

Tenth Rib Height \_\_\_\_\_ Thigh Circ., proximal \_\_\_\_\_

Waist Height, (P) \_\_\_\_\_ Calf Circ. \_\_\_\_\_

Waist Height, (O) \_\_\_\_\_ Ankle Circ. \_\_\_\_\_

Patella Top Height \_\_\_\_\_ Foot Breadth \_\_\_\_\_

Chest Breadth \_\_\_\_\_ Sitting Height \_\_\_\_\_

Chest Breadth (BB) \_\_\_\_\_ Cervicale Height, Sitting \_\_\_\_\_

Waist Breadth, (P) \_\_\_\_\_ Knee Ht, Sitting \_\_\_\_\_

Waist Breadth, (O) \_\_\_\_\_ Buttock-Knee Length \_\_\_\_\_

Hip Breadth \_\_\_\_\_ Abdominal Ext. Depth, Sit \_\_\_\_\_

Hip Breadth, Sitting \_\_\_\_\_

Hand Breadth \_\_\_\_\_

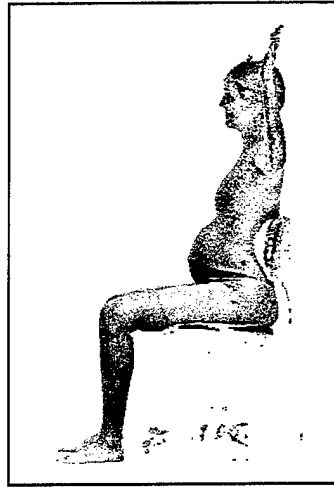
A scan evaluation form was completed for each subject during each session. The scan evaluation form contains information regarding the subject, the size of experimental clothing worn, the filename of the scans, the scan data, and general comments. Table 3 includes the scan evaluation form. Subjects were scanned in both a seated and a standing posture.

**Table 3. Whole-Body Scan Evaluation Form.**

WHOLE-BODY SCAN EVALUATION FORM				
<b>SUBJECT DATA</b>				
SUBJECT NAME:			SUBJECT NO.:	
DATE OF BIRTH:		RACE:		PLEASE CIRCLE ONE:
____ / ____ / ____ Day      Month      Year		White		Black
		Hispanic		Asian
		American Indian/Alaska Native		
		Other:		
				Military Civilian
<b>EXPERIMENTAL DATA</b>				
FILENAME:		DATE:		SCAN NO.:
<b>BODY DATA</b>				
SKIN ARTIFACTS ( <i>e.g., wrinkles, scars, etc.</i> ):			HEAD HAIR COLOR:	
HEAD HAIR LENGTH:			HEAD HAIR STYLE:	
Short      Medium				
Long				
POSTURE COMMENTS:				
<b>CLOTHING INFORMATION</b>				
CAP SIZE:		SHORT SIZE:		BRA SIZE:
REMARKS ON CLOTHING FIT:				
<b>SCANNER DATA</b>				
	HEAD 1	HEAD 2	HEAD 3	HEAD 4
Sensitivity	60	60	70	70
<b>SCANNING EVALUATION</b>				
	SCAN 1 - STAND		SCAN 2 - SIT	
Head Rotation				
Movement Artifacts				
Missing Data				
Reflections				
GENERAL COMMENTS:				

#### Seated Posture:

The seated scanning posture maximized body surface coverage and landmark visibility (Figure 6).



**Figure 6. Sitting Posture for Scanning.**

This posture required the subject to sit erect in a chair looking straight ahead with her head in the Frankfurt Plane. The scan technician aligned the feet with the hip and adjusted the knee angle to slightly greater than  $90^\circ$  ( $92^\circ$  or  $93^\circ$ ). The desired knee angle was achieved by raising or lowering the chair with the lever on the side of the chair. With some subjects, the chair was positioned as far down as possible, and the knee angle was still too great. The same foot boxes used for the traditional anthropometry were also used here to help align the knee to the desired angle. The subject held her hands over her head in the midsagittal plane. Arms were abducted  $90^\circ$ , elbows flexed  $90^\circ$ , lower arms in the frontal plane, and fingers were spread with thumbs pointed toward the body. Shading was eliminated and this arm position was easily reproducible because of the right angle at the shoulder and elbow. This arm position also prevented any shading of the subject's abdominal area.

#### Standing Posture:

The standing posture requires the subject to stand erect on the platform looking straight ahead with the head in the Frankfurt Plane (see Figure 7). The feet were

positioned shoulder width apart, aligned with the foot position stickers on the scanner platform. The arms were rotated to a forward reach in the horizontal plane of the shoulders. The hands were positioned shoulder width apart with the fingers together and the thumbs pointing upward. This position also prevented shading of the abdominal area.



**Figure 7. Standing Posture for Scanning.**

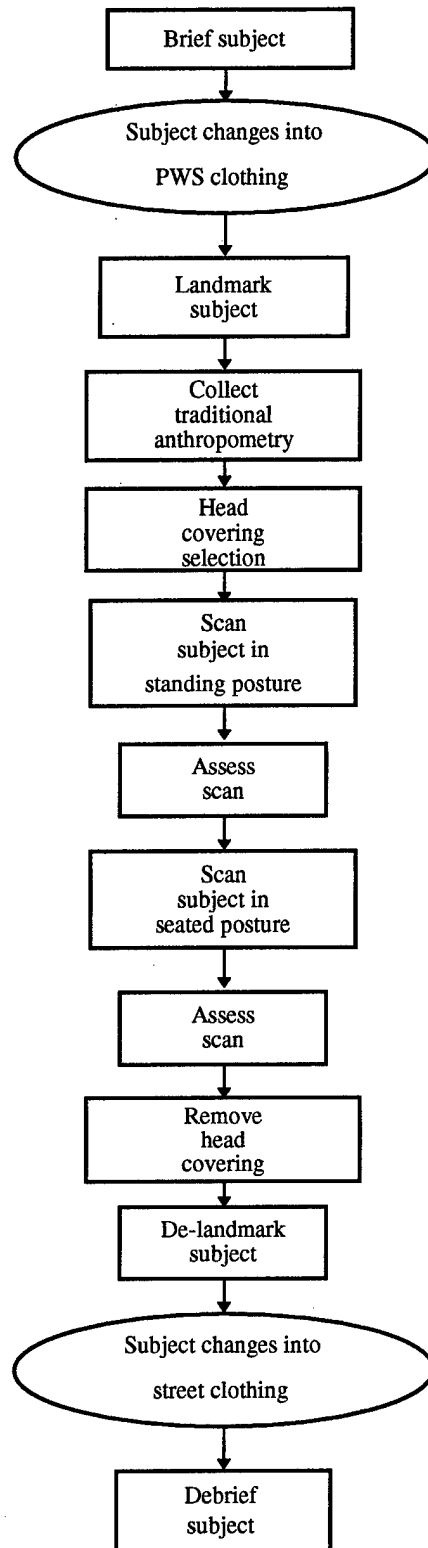
#### Occupational Information

Subjects were asked to complete a general questionnaire before completing the study. The questionnaire covers a broad range of topics related to the subject's work environment. Appendix E contains the completion questionnaire.

#### Data Collection Process

The entire data collection process is briefly described below and outlined in Figure 8.

Brief Subject: At the beginning of each subject's first session, an investigator briefed the subject on the procedure and equipment used in the study. Additionally, the subject read and signed the following:



**Figure 8. Data Collection Flow.**

- The CARD Laboratory's consent form: Protocol 83-30 (Version 1.2/04 October 96).
- The Informed Consent Document of the 74<sup>th</sup> Medical Group at Wright-Patterson Medical Center

Wright-Patterson Regional Medical Center required both the subject and the father of the baby to sign the consent forms. For that reason, subjects were encouraged to take the consent forms with them in order to obtain the necessary signatures. Appendix F contains the consent forms for this study. Finally, subjects were given a PWS questionnaire and were instructed to fill out and bring the completed questionnaire with them to the next data collection session.

Subject Changes Into Experimental Clothing: Next, the subject changed from street clothing into the experimental clothing for the actual data collection. The experimental clothing consisted of a pair of bike shorts and a sports bra. The shorts were maternity bike shorts purchased from Lazarus (a local department store). Sizes for the shorts ranged from S to XL. Non-maternity bike shorts were also available for those subjects who did not require maternity clothing for early sessions, or for the post-delivery sessions. The tops were regular sports bras purchased from Wal-Mart. Top sizes ranged from S to XXL. Investigators chose the appropriate size garments for each subject throughout the study. Garments had to fit so they conformed to the body without compressing tissue. Both the shorts and tops were light gray in color. (This was necessary for the scanning portion of the study: research in the CARD Laboratory determined that light gray was the optimal color for garments worn during the scanning. The light gray material allowed us to gather the maximum amount of data with as few reflections possible). Both the shorts and the tops consisted of a cotton/spandex material, which allowed the clothing to conform to the body and to the capture its shape. The cotton/spandex material also helped the garments maintain their size specifications despite repeated laundering.

Landmark Subject: Once the subject had donned the experimental clothing, anthropometric technicians located and marked anatomical landmarks with an eyeliner

pencil and blue adhesive dots, or stickers. The landmarks were located by visual inspection or by palpation (examination by touch) and marked with an eyeliner pencil first. Cover Girl *Perfect Blend* eyeliner pencils purchased from Wal-Mart were used for landmarking. Next, technicians covered the eyeliner marks with round, blue 9 mm adhesive dots which are visible in the scan data (the eyeliner marks are not). Avery brand adhesive dots were ordered in bulk quantity, which reduced cost considerably. Descriptions of the landmarks are included in Appendix D.

Traditional Anthropometry: Trained personnel measured the anthropometric dimensions in a manner which ensured precision and consistency. Technicians used standard anthropometric tools to measure the dimensions of interest. Appendix D contains descriptions of these dimensions. A glossary of related terms is also included in Appendix D.

Selection of Head Covering: Head covering was necessary during scanning to hide hair, which does not reflect light well and results in holes (or missing data) on, or near, the head region. Technicians determined the appropriate selections of head coverings for subjects before scanning. The head coverings consisted of latex caps which were made in the CARD Laboratory using head forms created from head data from a 1990 Survey of male U. S. Air Force pilots.

The latex scanning caps were available in eight different size/shape combinations where A was the "largest" size and H was the "smallest" size. Once a subject's cap size was determined during her first session, it was recorded on her scan evaluation form. For consistency, the same cap was used for that subject throughout the study. Because the only available head forms were created using data from male pilots, several subjects were scanned wearing the smallest head covering (cap H). For most of these subjects, cap H, although the "smallest," was still too large.

Scan Subject: After collecting the traditional anthropometric data, and after selecting the proper head covering, each subject was ready to be scanned with the Cyberware whole-body scanner. The scans captured the 3-D location of the physical marked landmarks as well as the subject's shape. The researcher would verify that each of the adhesive landmark dots was intact before the subject was correctly positioned on



the scanner platform and the scan was taken. Each scan took less than 20 seconds, which helped minimize error due to subject movement or sway.

Assess Scan: Once the scan was taken, a technician checked the data for errors. If no errors occurred, the scan data was saved. If an error occurred, the subject was re-scanned. Possible error types include: subject movement or sway during the scan, missing landmarks (landmarks that may have fallen off prior to scanning), clothing which had shifted out of proper position (this would result in the movement of landmarks that were placed on the clothing rather than directly on the skin), incorrect posture, fetal movement during the scan, scanner hardware problems, or operating software problems.

De-landmark Subject: After data collection was complete, all landmarks were removed, including the adhesive dots. The eyeliner pencil marks were removed with isopropyl rubbing alcohol.

Debrief Subject: Once a subject had changed back into her street clothing, several miscellaneous items were completed. Among these items was a payroll form, which was completed for all civilian (non-military) subjects. Appendix C contains the payroll record form for this study. Finally, the subject was scheduled for her next session, if applicable.

## ANALYSIS

### Demographic and Descriptor Data

Table 4 shows the distribution of the age at the initial session for the 25 subjects who completed the baseline session and at least one additional session in this study. This table shows that the range of ages for women in child-bearing years is well represented by this sample. Sixty-eight percent of the women were between the ages of 23 and 30 years and the other 32% were between the ages of 32 and 37 years.

Table 5 shows the race distribution of the subjects in this study. Minorities were not well-represented by this sample with only three non-white women participating. Since subjects participated on a voluntary basis, we could not obtain a sample with the same racial mixture as the tri-service active-duty female population.

**Table 4. Age Distribution for Pregnant Women's Study 1997.**

Age	Frequency	Percent	Cumulative Frequency	Cumulative Percent
23	2	8.0	2	8.0
24	2	8.0	4	16.0
25	3	12.0	7	28.0
26	3	12.0	10	40.0
27	5	20.0	15	60.0
28	1	4.0	16	64.0
29	1	4.0	17	68.0
32	1	4.0	18	72.0
34	4	16.0	22	88.0
35	2	8.0	24	96.0
37	1	4.0	25	100.0

**Table 5. Race Distribution for Pregnant Women's Study 1997.**

Race of Baby's Mother	Frequency	Percent
Black	1	4.0
Hispanic	2	8.0
White	22	88.0
Total	25	100.0

Table 6 shows the racial distribution of the baby's mother and father. Eighty-four percent (21 of 25) of the parent racial combinations were White/White.

**Table 6. Contingency Table for Race of Baby's Mother and Father.**

(a) Other = Black/White

(b) Other=White/Hispanic/American Indian or Alaska Native

Race of Baby's Mother	Race of Baby's Father				Total
	Black	Hispanic	White	Other	
Black	0	0	1	0	1
Hispanic	0	0	1	1 (a)	2
White	0	0	21	1 (b)	22
Other	0	0	0	0	0
Total	0	0	23	2	25

Table 7, showing the current pregnancy number and the number of previous live births, indicates that four of the subjects had one miscarriage prior to the current pregnancy.

**Table 7. Contingency Table for Current Pregnancy Number and Previous Live Births.**

Pregnancy Number	Previous Live Births				Total
	0	1	2	3	
1	16	0	0	0	16
2	1	4	0	0	5
3	0	1	1	0	2
4	0	0	2	0	2
Total	17	5	3	0	25

Figure 9 shows the distribution of heights and weights from the initial sessions of the 25 subjects who completed the baseline session and at least one additional session. The initial session height and weight are not necessarily the pre-pregnancy height and weight. Subjects were between four weeks and 16 weeks pregnant at the first session.

Joint bivariate scatter plots of height and weight comparing this study's participants to past samples of different female active-duty military members are given in Figure 10 through Figure 12. These figures show the heights and weights of the pregnant women at the first data collection session.

Figure 10 compares the heights and weights of the PWS subjects to the data collected from female active-duty Air Force members in 1968. Next, Figure 11 compares the PWS data to data from the female U.S. *Army Anthropometric Survey (ANSUR)* collected in 1988. Finally, Figure 12 compares the PWS subject data to that of the female active-duty Navy members collected in 1988. Although the PWS sample does not cover the entire range of heights and weights for the female active-duty population, the population is well-represented by this sample.

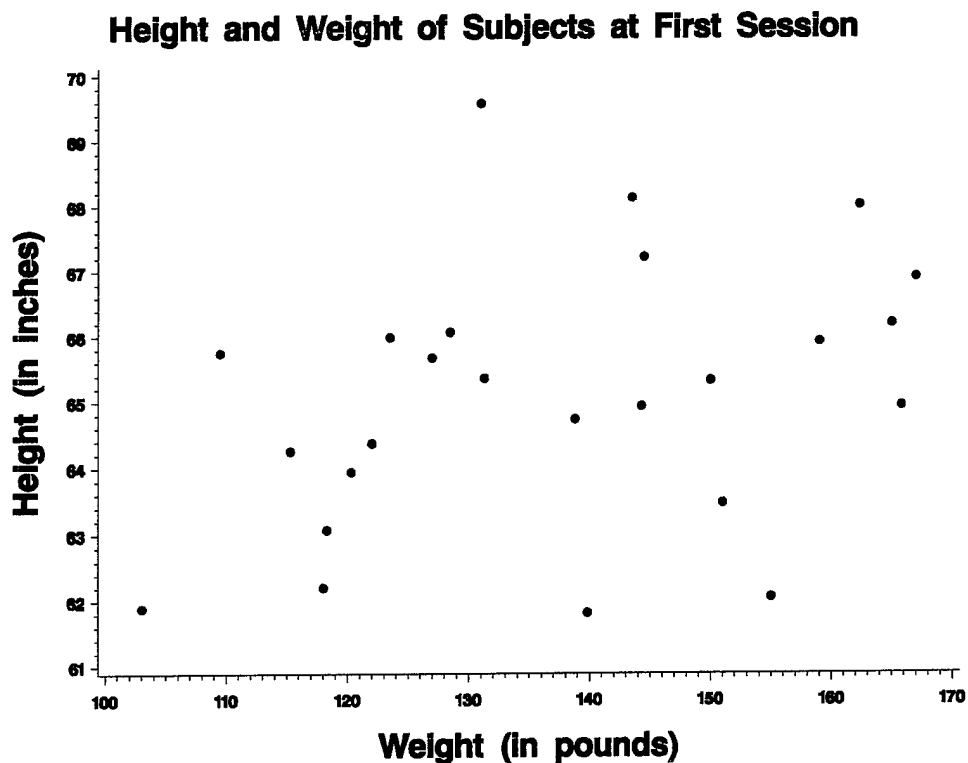


Figure 9. Height and Weight Distribution of Subjects at Initial Session.

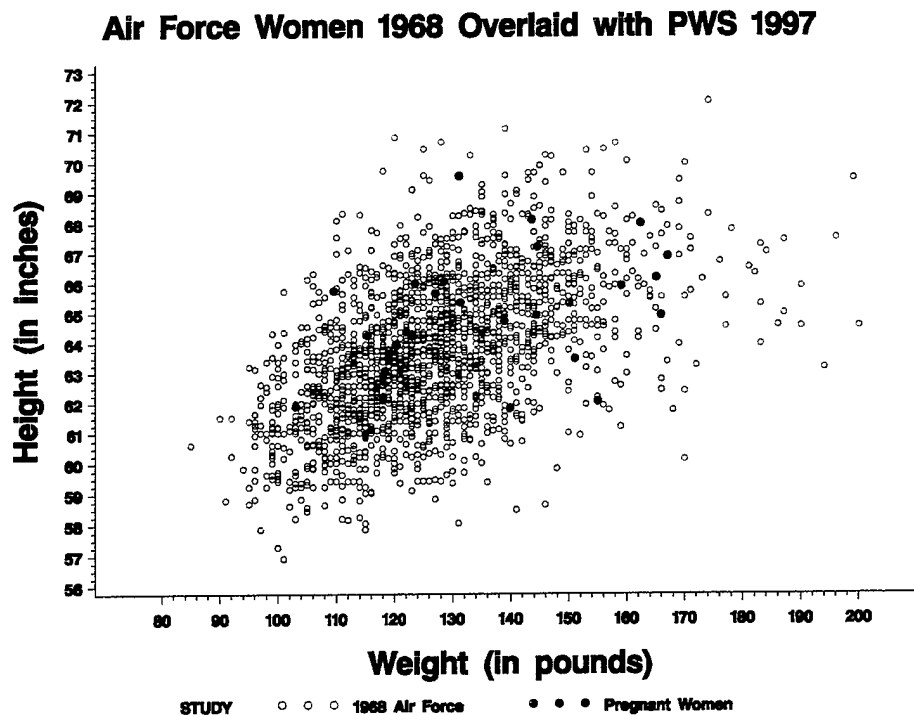


Figure 10. Height and Weight Plot of AF Women (1968) and PWS Subjects.

### Army Women 1988 Overlaid with PWS 1997

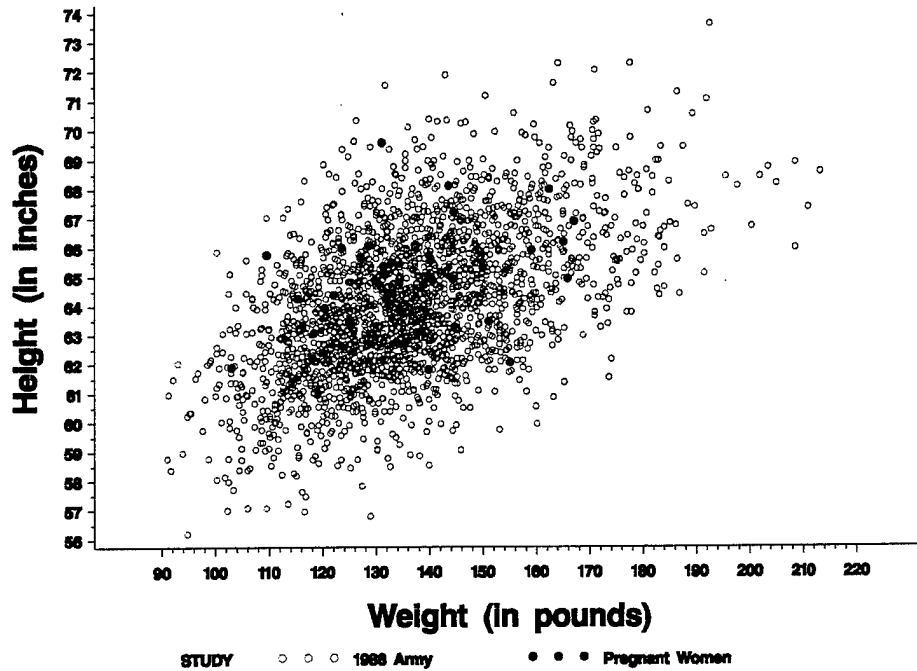


Figure 11. Height and Weight Plot of Army Women (1988) and PWS Subjects.

### Navy Women 1988 Overlaid with PWS 1997

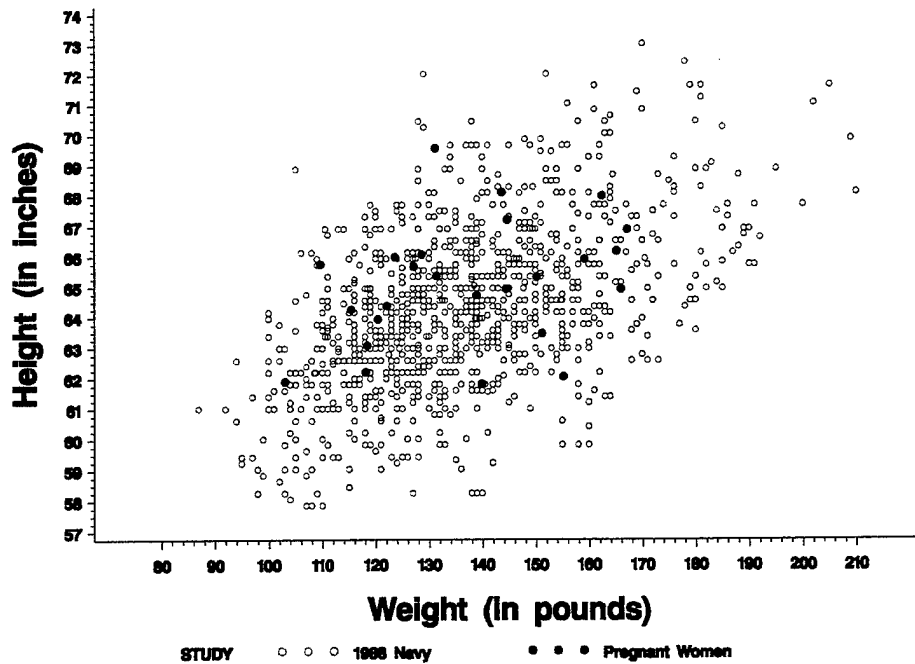


Figure 12. Height and Weight Plot of Navy Women (1988) and PWS Subjects.

### Questionnaire Data

The 25 subjects who completed the baseline session and at least one additional session also completed a questionnaire. In this questionnaire, subjects responded to many questions, including what type of job they had: desk or non-desk; standing or sitting; whether they type; and if they encounter any reach problems. A complete listing of the responses is given in Appendix G. These data are summarized in the following sections.

It was noted, however, that the questionnaire response data reflect the ability of the woman to perform job activities early in her pregnancy. No questionnaire data were collected during the later stages of pregnancy to determine how, or if, the woman's ability to perform these same job activities had changed. These data should be collected in any future research effort of this type.

Only the 25 subjects who completed the baseline session and at least one additional session, and who responded to the questionnaire are included in the following summaries.

#### General Work Data

Of the 25 subjects who responded to the questionnaire, 16 were civilians and nine were military members. Eighteen subjects were employed (nine military and nine civilians), and seven (civilians) were unemployed. Eight of the military members were in the Air Force and the other was in the Navy.

Of the 18 employed subjects, two worked part-time (less than 30 hours per week), 10 worked full-time (35 to 40 hours per week), and six worked more than 40 hours per week. Seven subjects had non-desk jobs, eight had desk jobs, two had a job which was a combination of desk and non-desk work, and one subject did not respond. Two respondents said they primarily sit at work, two said they stand, and 13 said they both sit and stand. Table 8 shows the frequencies and frequency percentages for the relationship between desk and non-desk jobs and whether the subjects sit or stand at work.

**Table 8. Cross-Tabulation of Desk or Non-Desk Jobs and Whether Worker Sits or Stands.**

Desk or Non-Desk?	Sit or Stand?			Total
	Sit	Stand	Both	
Desk	2 11.76	0 0.00	6 35.29	8 47.06
Non-Desk	0 0.00	2 11.76	5 29.41	7 41.18
Both	0 0.00	0 0.00	2 11.76	2 11.76
Total	2 11.76	2 11.76	13 76.47	17 100.00

Seventeen of the 18 employed subjects responded to questions concerning typing tasks. Thirteen of the 17 respondents stated they perform typing tasks during the workday. Only five of those have wrist pads for typing. Two of the 13 did not give their time spent typing, eight spend three hours or less, while the other three spend between five and seven hours per day typing. Table 9 shows the relationship between how many hours are spent typing and whether the subject uses a wrist pad.

**Table 9. Cross-Tabulation of use of Wrist Pad and Average Daily Hours Spent Typing.**

(DNR = Did Not Respond)

Wrist Pad?	Average Hours Typing Per Day									Total
	DNR	0.5	1.0	1.5	2.0	2.5	3.0	5.0	7.0	
DNR	12 48.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	12 48.00
No	1 4.00	2 8.00	0 0.00	0 0.00	0 0.00	1 4.00	1 4.00	2 8.00	1 4.00	8 32.00
Yes	1 4.00	0 0.00	1 4.00	1 4.00	1 4.00	1 4.00	0 0.00	0 0.00	0 0.00	5 20.00
Total	14 56.00	2 8.00	1 4.00	1 4.00	1 4.00	2 8.00	1 4.00	2 8.00	1 4.00	25 100.00

Fifteen of the 18 employed subjects take a lunch break during the day, two do not take a lunch break, and one did not respond to the question. Table 10 shows the

frequencies and frequency percentages for the average length of the lunch breaks for those subjects who take a lunch break and responded to the question.

Thirteen of the employed subjects take breaks during the day, four do not take breaks and one did not respond to the question. Average length of a break ranges from five minutes to 25 minutes. Breaks are taken from "as often as needed" to one per day. Table 11 shows the frequency and frequency percentages of how often breaks are taken with the length of the break.

**Table 10. Frequency Table of Average Lunch Break (in minutes).**

Average Lunch Break (minutes)	Frequency	Percent	Cumulative Frequency	Cumulative Percent
20	1	6.7	1	6.7
25	2	13.3	3	20.0
30	4	26.7	7	46.7
35	1	6.7	8	53.3
45	5	33.3	13	86.7
60	2	13.3	15	100.0

**Table 11. Cross-Tabulation of How Often Breaks are taken and Length of Break (in minutes).**

Average Length (minutes)	How Often Breaks Are Taken								TOTAL
	1/day	2/day	3/day	1/2.5 hr	1/1.5 hr	1/hour	2/hour	As needed	
0 - 5	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	1 7.69	0 0.00	0 0.00	1 7.69
6 - 10	0 0.00	0 0.00	0 0.00	0 0.00	1 7.69	2 15.38	1 7.69	1 7.69	5 38.46
11 - 15	2 15.38	1 7.69	0 0.00	1 7.69	1 7.69	0 0.00	0 0.00	0 0.00	5 38.46
16 - 20	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00
21 - 25	0 0.00	1 7.69	1 7.69	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	2 15.38
TOTAL	2 15.38	2 15.38	1 7.69	1 7.69	2 15.38	3 23.08	1 7.69	1 7.69	13 100.00



## Standing

Fifteen subjects either primarily stand on the job, or both sit and stand on the job. These 15 subjects responded to questions concerning standing on the job. Of those subjects, three stand 25% of the work day or less, four stand between 26 and 50% of the day, three stand between 50 and 63% of the time, while four stand between 80 and 90% of the day (one subject did not respond to this question).

Six subjects spend less than 20 minutes in any one standing position, three spend from 45 minutes to one hour in the same standing position, three spend between two and two and one-half hours in one position, and one spends over three hours in one position (two subjects did not respond to this question).

For the 15 subjects who stand on the job, five operate machinery while standing, nine do not operate machinery, and one did not respond to the question.

Subjects were questioned about whether they lift objects while standing at work. Additionally, they were asked how frequently they lift the objects, what dimensions the objects are and how much the objects weigh. Four subjects stated they do not lift objects while standing at work, 10 do lift objects, and one did not respond to the question. (The sizes of the objects are given in the questionnaire response listings in Appendix G.) Table 12 shows the frequencies and frequency percentages of how often and how much weight is lifted by subjects while standing on the job.

**Table 12. Cross-Tabulation of How Often and How Much Weight is Lifted by Subjects While Standing on the Job.**

(DNR = Did Not Respond)

Weight (in lbs.)	How Often Object Is Lifted								TOTAL
	DNR	2/month	1/week	1/day	8/day	5/hour	10/hour	Often	
DNR	5 33.33	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	5 33.33
0 - 5	0 0.00	0 0.00	1 6.67	0 0.00	0 0.00	0 0.00	1 6.67	1 6.67	3 20.00
6 - 10	1 6.67	0 0.00	0 0.00	1 6.67	0 0.00	0 0.00	1 6.67	0 0.00	3 20.00
11 - 15	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	1 6.67	0 0.00	0 0.00	1 6.67
36 - 40	0 0.00	0 0.00	0 0.00	0 0.00	1 6.67	1 6.67	0 0.00	0 0.00	2 13.33
46 - 50	0 0.00	1 6.67	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	1 6.67
TOTAL	6 40.00	1 6.67	1 6.67	1 6.67	1 6.67	2 13.33	2 13.33	1 6.67	15 100.00

### Sitting

Fifteen subjects either primarily sit on the job, or both sit and stand on the job. These 15 subjects responded to questions concerning sitting on the job. Two sit 25% of the work day or less, three sit between 26 and 50% of the day, four sit between 50 and 75% of the time, while the other six sit between 80 and 100% of the day.

Three subjects spend less than 20 minutes in any one sitting position, seven spend from 45 minutes to one hour in the same sitting position, four spend between one and two hours in one position, and one spends over two hours in one sitting position.

Eight of the 15 subjects operate machinery while they sit, and five of the 15 lift objects while they sit. All five of those subjects stated that they lift objects weighing less than five pounds from as seldom as twice per day to as often as 30 times per hour. These frequencies and frequency percentages are shown in Table 13.

**Table 13. Frequency Table of How Often Subjects Lift Objects Weighing Less Than 5 Pounds, While Sitting at Work.**

How Often Object Is Lifted	Frequency	Percent	Cumulative Frequency	Cumulative Percent
2 times / day	1	20.0	1	20.0
2 times / hour	1	20.0	2	40.0
10 times / hour	1	20.0	3	60.0
30 times / hour	1	20.0	4	80.0
Often	1	20.0	5	100.0

### Reach

All subjects were questioned about any difficulties encountered during the work day while reaching for objects. Seventeen of the 18 employed subjects responded to those questions. Of the 17 who responded, only four said that during the workday they have difficulty reaching for an object or objects with one arm. The four who experience difficulties reach between two feet and five feet on average. Two said they reach in all directions, one reaches to the left and right, and the other reaches up and to the right. Three of the four who have difficulties reaching for objects with one arm said the objects seldom to never have good handles or grips. The fourth person, however, said the objects for which she reaches do have good handles or grips.

Only two of the 17 respondents experience difficulties during the work day in reaching for objects with both arms. Both of those subjects stated they typically reach for those objects from a distance of about three feet and the directions reached are all directions. One subject said the objects do have good handles or grips, while the other said the objects occasionally have good handles.

### Traditional Anthropometry

#### Summary Statistics for Linear Measurements

Thirty-five subjects participated in at least one data collection session in this study. Of those, 10 completed only the first session. One subject only completed the first two sessions. Three subjects completed the first three sessions. One subject completed sessions one, two and four. Another subject completed the first four sessions.

Four subjects completed five sessions. (One completed the first five sessions and did not return for the sixth session after her baby was born. One was not scheduled for her third session due to a scanner malfunction. The other two subjects missed their fifth sessions because they delivered early.) Fifteen subjects completed all six sessions. The data for the 10 subjects who only participated in the first data collection session are being provided as part of the electronic files, but are not included in the statistical analysis or data summaries.

Although the initial sessions were scheduled after the subjects found out about their pregnancies and before visible physical changes had occurred, the number of weeks into pregnancy were not consistent between subjects. Follow-up sessions were scheduled according to number of weeks pregnant with very little variation occurring between the subjects. The mean, standard deviation, minimum, and maximum weeks of pregnancy for each session are given in Table 14. The information in Table 14 is for the 15 subjects who completed all six data collection sessions (Session 6 represents post-delivery).

The second session was to be completed at 20 weeks; the third session, between 28 and 29 weeks; the fourth session, between 32 and 33 weeks; and the fifth session, between 37 and 38 weeks. The sixth session, or post-delivery session, was to be completed within a month of delivery. On average, sessions two through six were scheduled with very little deviation from the pre-selected (or target) number of weeks (Table 14, Weeks of Pregnancy for Each Session).

**Table 14. Weeks of Pregnancy for Each Session (N=15).**

Session	Weeks of Pregnancy			
	Mean	Standard Deviation	Minimum	Maximum
1	8.0	2.3	4	12
2	20.9	1.7	18	24
3	28.3	0.7	27	30
4	32.3	0.6	31	33
5	37.2	0.6	37	39
6	3.7	1.8	2	8.5

Table 15 provides summary statistics which describe the traditional anthropometry for the 15 subjects who completed all six data collection sessions. Weight is in pounds, and all other measurements are in centimeters. The measurement means, standard deviations, minimums, and maximums are given in Table 15. The ranges and standard deviations are useful for designers to understand the variability inherent in the population of pregnant women.

For informational purposes, the summary statistics describing the traditional anthropometry for the subjects who completed the baseline session (Session 1) and at least one additional session are given in Appendix H. The mean, standard deviation, minimum, and maximum weeks of pregnancy for each session are given for these subjects in Table H-1.

#### Summary Statistics for the Changes from Baseline

Summary statistics describing the actual (not percent) changes in traditional anthropometric measurements from baseline (Session 1) are given in Table 16 for the 15 subjects who completed all six data collection sessions. The changes from baseline (Session 1), for each measurement and session (Session 2 through Session 6), were used in a two-tailed  $t$ -test for  $H_0$ : change = 0. The measurements that showed a significant change from Session 1 ( $p$ -values  $\leq 0.05$ ) are highlighted in Table 16.

For informational purposes, the summary statistics describing the changes in traditional anthropometric measurements from baseline (Session 1) are given in Appendix I for the subjects who completed the baseline session and at least one additional session. Changes that are significantly different ( $p$ -values  $\leq 0.05$ ) are highlighted in the table.

Using Tables 14-16, some conclusions can be drawn from the traditional anthropometry. For example, consider Tenth Rib Height. On average, women in their 32<sup>nd</sup> week of pregnancy (Session 4), had an increase of 2.9 cm in Tenth Rib Height from their 8<sup>th</sup> week of pregnancy (Session 1). This change was significant at a 5% level of significance.

**Table 15. Summary Statistics for Linear Measurements (N=15).**  
(Weight is in lbs., all others in cm)

Measurement Name	Session	Mean	Standard Deviation	Minimum	Maximum
Abdominal Ext. Depth, Sitting	1	21.85	3.17	16.60	27.00
Abdominal Ext. Depth, Sitting	2	26.41	3.38	21.40	32.00
Abdominal Ext. Depth, Sitting	3	29.60	2.76	25.50	34.00
Abdominal Ext. Depth, Sitting	4	31.25	2.89	26.00	36.40
Abdominal Ext. Depth, Sitting	5	33.09	2.93	28.20	38.60
Abdominal Ext. Depth, Sitting	6	25.13	3.35	19.20	31.50
Ankle Circumference	1	21.36	1.15	19.10	23.10
Ankle Circumference	2	21.21	1.10	18.90	22.50
Ankle Circumference	3	21.51	1.32	19.00	23.50
Ankle Circumference	4	21.57	1.31	18.90	23.30
Ankle Circumference	5	22.25	1.73	19.00	25.60
Ankle Circumference	6	21.03	1.34	18.50	22.80
Buttock-Knee Length	1	58.18	2.01	53.40	60.10
Buttock-Knee Length	2	58.55	1.61	54.60	60.80
Buttock-Knee Length	3	59.22	1.73	55.90	61.90
Buttock-Knee Length	4	59.42	1.83	54.80	61.80
Buttock-Knee Length	5	59.35	2.08	54.40	62.00
Buttock-Knee Length	6	58.81	1.68	54.90	61.30
Calf Circumference	1	36.20	3.01	31.70	41.00
Calf Circumference	2	36.54	3.07	31.50	42.00
Calf Circumference	3	36.99	3.19	32.30	42.10
Calf Circumference	4	37.15	3.11	32.70	42.30
Calf Circumference	5	37.71	3.21	33.20	43.10
Calf Circumference	6	35.90	3.06	31.10	40.90
Cervicale Height, Sitting	1	64.11	2.61	59.00	68.90
Cervicale Height, Sitting	2	64.27	2.58	59.80	69.00
Cervicale Height, Sitting	3	64.13	2.49	59.80	69.10
Cervicale Height, Sitting	4	64.03	2.40	59.70	67.40
Cervicale Height, Sitting	5	64.07	2.45	59.50	68.30
Cervicale Height, Sitting	6	63.59	2.19	59.50	66.70
Cervicale Height	1	141.85	4.51	134.80	150.30
Cervicale Height	2	141.74	4.31	134.30	149.10
Cervicale Height	3	141.63	4.34	134.00	149.90
Cervicale Height	4	141.39	4.49	133.40	149.70
Cervicale Height	5	141.47	4.35	134.30	148.80
Cervicale Height	6	141.10	4.12	133.60	147.70

### Summary Statistics for Linear Measurements (N=15)

Measurement Name	Session	Mean	Standard Deviation	Minimum	Maximum
Chest Breadth	1	28.65	2.11	25.60	31.60
Chest Breadth	2	29.70	2.54	26.20	34.00
Chest Breadth	3	30.48	2.22	27.00	34.20
Chest Breadth	4	30.80	2.37	27.20	35.50
Chest Breadth	5	30.94	2.45	27.20	34.80
Chest Breadth	6	29.59	2.55	26.20	33.90
Chest Breadth Below Bust	1	26.85	1.74	23.80	29.50
Chest Breadth Below Bust	2	27.19	1.84	23.50	29.60
Chest Breadth Below Bust	3	28.01	1.75	24.50	30.30
Chest Breadth Below Bust	4	28.14	1.69	24.80	30.60
Chest Breadth Below Bust	5	28.41	1.60	24.80	30.70
Chest Breadth Below Bust	6	26.73	1.68	23.80	29.60
Chest Circumference	1	89.56	7.18	81.30	101.50
Chest Circumference	2	93.63	7.33	83.70	108.40
Chest Circumference	3	96.21	8.14	85.00	113.80
Chest Circumference	4	96.75	8.03	85.10	113.30
Chest Circumference	5	98.36	8.26	87.50	114.10
Chest Circumference	6	95.89	7.86	83.20	109.60
Chest Circumference Below Bust	1	76.60	5.11	66.00	83.90
Chest Circumference Below Bust	2	79.23	4.89	70.80	89.50
Chest Circumference Below Bust	3	81.53	4.95	74.20	91.80
Chest Circumference Below Bust	4	82.30	5.08	75.20	93.00
Chest Circumference Below Bust	5	84.06	4.72	76.80	92.90
Chest Circumference Below Bust	6	78.57	4.32	71.50	85.00
Chest Depth	1	23.20	2.37	19.90	27.90
Chest Depth	2	24.18	2.61	20.80	30.30
Chest Depth	3	24.74	2.44	21.60	29.80
Chest Depth	4	24.91	2.39	21.20	29.90
Chest Depth	5	24.96	2.37	21.40	30.20
Chest Depth	6	24.28	2.55	20.60	29.50
Chest Depth Below Bust	1	19.70	1.59	17.20	22.50
Chest Depth Below Bust	2	20.40	1.84	17.40	24.80
Chest Depth Below Bust	3	21.23	1.72	18.30	25.30
Chest Depth Below Bust	4	21.74	1.76	18.60	25.60
Chest Depth Below Bust	5	21.87	1.83	18.10	25.60
Chest Depth Below Bust	6	19.59	1.56	16.60	22.80

### Summary Statistics for Linear Measurements (N=15)

Measurement Name	Session	Mean	Standard Deviation	Minimum	Maximum
Chest Height	1	119.48	3.98	112.70	128.80
Chest Height	2	119.61	4.32	112.60	128.70
Chest Height	3	120.41	4.21	112.70	129.70
Chest Height	4	120.11	4.08	112.80	129.80
Chest Height	5	120.59	3.58	113.70	128.10
Chest Height	6	117.67	4.26	110.50	128.00
Chest Height Below Bust	1	114.33	3.49	109.40	122.50
Chest Height Below Bust	2	113.79	3.97	107.00	122.30
Chest Height Below Bust	3	114.41	3.86	106.90	123.00
Chest Height Below Bust	4	114.56	3.85	108.00	123.20
Chest Height Below Bust	5	115.13	3.46	109.00	123.10
Chest Height Below Bust	6	112.19	3.64	106.30	121.40
Foot Breadth	1	8.95	0.40	8.30	9.50
Foot Breadth	2	8.77	0.30	8.20	9.30
Foot Breadth	3	8.65	0.41	8.00	9.30
Foot Breadth	4	8.85	0.50	7.90	9.70
Foot Breadth	5	8.79	0.38	8.40	9.40
Foot Breadth	6	8.81	0.44	8.20	9.50
Hand Breadth	1	7.57	0.36	7.00	8.30
Hand Breadth	2	7.55	0.40	7.00	8.20
Hand Breadth	3	7.64	0.38	7.00	8.40
Hand Breadth	4	7.65	0.39	7.00	8.20
Hand Breadth	5	7.74	0.37	7.00	8.40
Hand Breadth	6	7.67	0.38	7.00	8.30
Hip Breadth	1	36.21	2.66	32.00	41.80
Hip Breadth	2	37.06	2.65	32.50	42.00
Hip Breadth	3	37.65	2.76	33.20	43.80
Hip Breadth	4	37.58	2.71	33.90	43.90
Hip Breadth	5	37.57	2.64	33.80	43.10
Hip Breadth	6	36.99	2.80	33.10	42.20
Hip Breadth, Sitting	1	39.52	3.46	34.60	45.70
Hip Breadth, Sitting	2	40.55	3.28	35.10	45.60
Hip Breadth, Sitting	3	41.33	3.28	36.90	47.20
Hip Breadth, Sitting	4	41.55	3.38	36.80	47.80
Hip Breadth, Sitting	5	41.69	3.21	37.10	47.50
Hip Breadth, Sitting	6	40.48	3.20	36.40	45.70



### Summary Statistics for Linear Measurements (N=15)

Measurement Name	Session	Mean	Standard Deviation	Minimum	Maximum
Hip Circumference	1	98.89	7.71	86.60	111.50
Hip Circumference	2	101.84	6.89	87.90	110.70
Hip Circumference	3	103.80	7.38	90.70	114.40
Hip Circumference	4	104.93	7.52	92.40	117.80
Hip Circumference	5	106.21	8.03	93.40	117.00
Hip Circumference	6	101.25	9.86	76.80	112.50
Knee Height, Sitting	1	51.01	1.60	48.20	54.80
Knee Height, Sitting	2	51.11	1.53	48.40	54.80
Knee Height, Sitting	3	51.47	1.56	48.80	55.10
Knee Height, Sitting	4	51.53	1.59	49.10	55.20
Knee Height, Sitting	5	51.69	1.55	49.10	55.30
Knee Height, Sitting	6	51.47	1.63	48.80	55.10
Patella Top Height	1	47.99	1.85	45.70	51.90
Patella Top Height	2	47.86	1.67	45.90	51.40
Patella Top Height	3	48.27	1.73	45.30	51.90
Patella Top Height	4	48.07	1.75	45.90	51.90
Patella Top Height	5	48.34	1.71	45.60	52.40
Patella Top Height	6	48.25	1.51	46.30	52.00
Sitting Height	1	87.89	3.05	82.10	92.60
Sitting Height	2	88.13	3.04	82.70	92.80
Sitting Height	3	88.07	3.16	81.90	92.60
Sitting Height	4	88.04	3.11	82.20	92.00
Sitting Height	5	87.87	2.99	82.20	92.10
Sitting Height	6	87.41	2.88	81.50	91.20
Stature	1	165.67	5.06	157.20	176.70
Stature	2	165.64	4.99	157.10	176.40
Stature	3	165.54	5.06	156.50	176.60
Stature	4	165.43	5.03	156.50	176.30
Stature	5	165.51	5.02	156.60	176.10
Stature	6	164.81	4.75	156.80	174.90
Substernale Height	1	117.85	3.69	112.40	127.10
Substernale Height	2	118.23	3.77	112.00	126.40
Substernale Height	3	119.71	4.10	111.50	127.00
Substernale Height	4	119.23	3.95	111.50	126.70
Substernale Height	5	119.33	3.42	113.30	124.80
Substernale Height	6	116.78	3.60	110.30	124.90

### Summary Statistics for Linear Measurements (N=15)

Measurement Name	Session	Mean	Standard Deviation	Minimum	Maximum
Suprasternale Height	1	134.79	4.15	127.50	143.70
Suprasternale Height	2	134.85	4.24	127.30	143.50
Suprasternale Height	3	135.22	4.26	127.90	144.30
Suprasternale Height	4	134.99	4.26	127.10	143.80
Suprasternale Height	5	134.93	4.07	127.60	143.30
Suprasternale Height	6	134.15	4.15	126.60	142.40
Tenth Rib Height	1	107.61	2.85	103.10	113.90
Tenth Rib Height	2	108.48	3.79	103.30	118.00
Tenth Rib Height	3	110.11	3.68	103.50	117.40
Tenth Rib Height	4	110.51	3.42	104.00	118.20
Tenth Rib Height	5	110.99	3.65	104.10	118.60
Tenth Rib Height	6	107.30	3.14	100.80	114.20
Thigh Circumference, Proximal	1	58.57	5.86	49.00	65.70
Thigh Circumference, Proximal	2	60.21	5.26	49.60	67.50
Thigh Circumference, Proximal	3	61.19	5.22	52.20	69.20
Thigh Circumference, Proximal	4	61.52	5.34	52.60	69.50
Thigh Circumference, Proximal	5	62.09	5.51	52.70	70.20
Thigh Circumference, Proximal	6	59.63	5.88	50.00	68.00
Thumbtip Reach, Right	1	74.28	2.82	70.60	79.80
Thumbtip Reach, Right	2	74.07	2.98	69.60	79.40
Thumbtip Reach, Right	3	73.86	2.55	70.20	78.40
Thumbtip Reach, Right	4	73.93	2.64	69.80	77.70
Thumbtip Reach, Right	5	73.67	2.52	69.10	77.00
Thumbtip Reach, Right	6	74.42	2.80	68.10	78.70
Weight	1	138.55	21.76	103.00	167.00
Weight	2	149.21	22.41	110.00	181.50
Weight	3	157.52	23.22	116.00	196.00
Weight	4	161.03	23.45	119.50	201.50
Weight	5	167.85	24.94	122.50	214.00
Weight	6	145.95	23.22	108.80	178.50
Waist Breadth, Omphalion	1	28.45	3.34	22.90	35.30
Waist Breadth, Omphalion	2	29.75	3.04	26.10	36.00
Waist Breadth, Omphalion	3	31.08	3.26	26.20	36.40
Waist Breadth, Omphalion	4	31.68	3.58	26.80	37.30
Waist Breadth, Omphalion	5	32.40	3.30	27.30	37.60
Waist Breadth, Omphalion	6	30.75	3.75	25.50	37.50

### Summary Statistics for Linear Measurements (N=15)

Measurement Name	Session	Mean	Standard Deviation	Minimum	Maximum
Waist Breadth, Preferred	1	26.09	2.05	23.00	29.80
Waist Breadth, Preferred	2	27.05	1.66	23.70	30.10
Waist Breadth, Preferred	3	28.23	1.46	26.00	30.40
Waist Breadth, Preferred	4	28.77	1.51	26.20	31.30
Waist Breadth, Preferred	5	29.23	1.54	26.80	31.80
Waist Breadth, Preferred	6	27.67	2.08	24.80	30.80
Waist Circumference, Omphalion	1	79.43	9.99	65.50	96.70
Waist Circumference, Omphalion	2	89.74	10.41	76.40	105.50
Waist Circumference, Omphalion	3	98.21	9.63	82.00	112.80
Waist Circumference, Omphalion	4	101.57	9.86	85.60	119.50
Waist Circumference, Omphalion	5	107.05	9.84	91.60	123.70
Waist Circumference, Omphalion	6	88.27	10.37	73.20	107.40
Waist Circumference, Preferred	1	74.47	6.35	64.20	82.90
Waist Circumference, Preferred	2	82.21	5.94	71.70	91.10
Waist Circumference, Preferred	3	88.79	4.85	78.20	96.80
Waist Circumference, Preferred	4	91.51	4.23	84.10	99.40
Waist Circumference, Preferred	5	95.33	4.10	88.80	101.70
Waist Circumference, Preferred	6	81.34	6.21	72.50	91.70
Waist Depth, Omphalion	1	20.23	3.33	15.70	27.20
Waist Depth, Omphalion	2	24.55	3.78	19.20	32.00
Waist Depth, Omphalion	3	28.23	3.07	23.30	33.50
Waist Depth, Omphalion	4	29.87	2.82	25.80	34.50
Waist Depth, Omphalion	5	32.56	3.16	27.60	37.80
Waist Depth, Omphalion	6	22.45	3.41	17.20	29.30
Waist Depth, Preferred	1	19.14	2.32	14.90	23.10
Waist Depth, Preferred	2	22.37	2.25	18.30	25.70
Waist Depth, Preferred	3	25.38	1.61	21.60	27.70
Waist Depth, Preferred	4	26.80	1.34	24.10	28.90
Waist Depth, Preferred	5	28.45	1.23	26.30	30.30
Waist Depth, Preferred	6	21.09	2.44	17.50	25.00
Waist Height, Omphalion	1	98.95	3.79	92.50	106.40
Waist Height, Omphalion	2	98.62	3.55	93.90	107.40
Waist Height, Omphalion	3	98.15	3.34	93.20	106.20
Waist Height, Omphalion	4	97.46	3.14	93.20	105.40
Waist Height, Omphalion	5	96.90	3.23	91.50	104.80
Waist Height, Omphalion	6	97.96	3.73	92.50	106.40

### Summary Statistics for Linear Measurements (N=15)

Measurement Name	Session	Mean	Standard Deviation	Minimum	Maximum
Waist Height, Preferred	1	101.15	3.60	93.60	106.40
Waist Height, Preferred	2	102.51	4.72	94.40	111.00
Waist Height, Preferred	3	104.53	6.71	88.40	114.20
Waist Height, Preferred	4	103.33	8.15	87.50	118.00
Waist Height, Preferred	5	102.79	9.02	86.80	115.20
Waist Height, Preferred	6	100.83	4.06	91.90	106.30

**Table 16. Summary Statistics for the Actual Changes from Baseline (N=15).**  
(Weight is in lbs., all others in cm)

Measurement Name	Session	Mean	Standard Deviation	Minimum	Maximum	P-Value
Abdominal Ext. Depth, Sitting	2	4.56	1.71	2.00	8.40	0.0001
Abdominal Ext. Depth, Sitting	3	7.75	2.16	4.60	12.30	0.0001
Abdominal Ext. Depth, Sitting	4	9.39	2.25	5.60	13.10	0.0001
Abdominal Ext. Depth, Sitting	5	11.24	2.41	7.80	17.00	0.0001
Abdominal Ext. Depth, Sitting	6	3.27	2.67	-0.50	7.80	0.0003
Ankle Circumference	2	-0.15	0.60	-1.70	0.60	0.3634
Ankle Circumference	3	0.15	0.81	-1.50	1.40	0.4777
Ankle Circumference	4	0.21	0.74	-1.80	0.90	0.2996
Ankle Circumference	5	0.89	1.26	-1.70	3.30	0.0156
Ankle Circumference	6	-0.33	0.60	-2.00	0.50	0.0504
Buttock-Knee Length	2	0.37	0.63	-0.70	1.40	0.0388
Buttock-Knee Length	3	1.04	0.91	-0.20	2.70	0.0006
Buttock-Knee Length	4	1.24	0.63	0.40	2.70	0.0001
Buttock-Knee Length	5	1.17	0.97	-0.10	3.40	0.0004
Buttock-Knee Length	6	0.63	0.85	-1.10	1.80	0.0129
Calf Circumference	2	0.34	0.56	-0.60	1.00	0.0326
Calf Circumference	3	0.79	0.62	-0.30	1.80	0.0002
Calf Circumference	4	0.95	0.68	-0.30	2.10	0.0001
Calf Circumference	5	1.51	0.94	0.10	3.60	0.0001
Calf Circumference	6	-0.30	0.78	-2.50	0.70	0.1572
Cervicale Height, Sitting	2	0.16	0.80	-1.90	1.80	0.4524
Cervicale Height, Sitting	3	0.03	0.72	-1.60	1.30	0.8882
Cervicale Height, Sitting	4	-0.07	0.88	-1.90	1.00	0.7509
Cervicale Height, Sitting	5	-0.03	0.66	-1.30	1.00	0.8472
Cervicale Height, Sitting	6	-0.52	1.08	-2.30	1.00	0.0828
Cervicale Height	2	-0.11	0.71	-1.20	1.40	0.5458
Cervicale Height	3	-0.22	0.87	-1.80	1.10	0.3446
Cervicale Height	4	-0.46	0.97	-2.30	0.70	0.0872
Cervicale Height	5	-0.38	0.84	-1.60	0.90	0.1001
Cervicale Height	6	-0.75	1.04	-2.60	0.90	0.0143
Chest Breadth	2	1.05	0.97	-0.20	2.90	0.0010
Chest Breadth	3	1.83	0.81	0.80	3.70	0.0001
Chest Breadth	4	2.15	1.07	0.20	4.40	0.0001
Chest Breadth	5	2.29	1.12	0.10	4.00	0.0001
Chest Breadth	6	0.94	1.15	-0.80	2.80	0.0070

### Summary Statistics for the Actual Changes from Baseline (N=15)

Measurement Name	Session	Mean	Standard Deviation	Minimum	Maximum	P-Value
Chest Breadth Below Bust	2	0.34	0.59	-0.70	1.50	0.0440
Chest Breadth Below Bust	3	1.16	0.61	-0.10	2.20	0.0001
Chest Breadth Below Bust	4	1.29	0.73	0.00	2.50	0.0001
Chest Breadth Below Bust	5	1.57	0.85	0.00	2.90	0.0001
Chest Breadth Below Bust	6	-0.11	0.70	-1.30	0.80	0.5389
Chest Circumference	2	4.07	2.52	-0.20	8.70	0.0001
Chest Circumference	3	6.65	2.72	2.40	12.30	0.0001
Chest Circumference	4	7.19	2.92	2.50	12.90	0.0001
Chest Circumference	5	8.80	2.95	4.50	14.60	0.0001
Chest Circumference	6	6.33	3.71	0.60	13.60	0.0001
Chest Circumference Below Bust	2	2.63	2.19	-0.20	7.80	0.0004
Chest Circumference Below Bust	3	4.93	2.54	1.40	9.50	0.0001
Chest Circumference Below Bust	4	5.70	2.93	0.60	10.00	0.0001
Chest Circumference Below Bust	5	7.46	2.95	1.90	13.20	0.0001
Chest Circumference Below Bust	6	1.97	2.26	-1.50	7.50	0.0045
Chest Depth	2	0.98	0.80	-0.20	2.40	0.0003
Chest Depth	3	1.54	0.48	0.70	2.30	0.0001
Chest Depth	4	1.71	0.63	0.60	2.70	0.0001
Chest Depth	5	1.76	0.72	0.70	2.70	0.0001
Chest Depth	6	1.08	1.05	-1.10	2.70	0.0014
Chest Depth Below Bust	2	0.70	0.83	-1.40	2.50	0.0057
Chest Depth Below Bust	3	1.53	0.71	0.40	3.00	0.0001
Chest Depth Below Bust	4	2.04	0.94	0.50	3.50	0.0001
Chest Depth Below Bust	5	2.17	0.98	0.20	3.40	0.0001
Chest Depth Below Bust	6	-0.11	0.89	-2.30	1.20	0.6281
Chest Height	2	0.13	1.31	-2.30	2.40	0.7133
Chest Height	3	0.93	1.36	-1.00	4.10	0.0196
Chest Height	4	0.63	1.30	-1.90	3.10	0.0823
Chest Height	5	1.11	1.30	-1.00	3.30	0.0052
Chest Height	6	-1.76	1.03	-3.30	-0.50	0.0001
Chest Height Below Bust	2	-0.53	0.83	-2.40	0.70	0.0257
Chest Height Below Bust	3	0.08	1.22	-2.50	2.30	0.8032
Chest Height Below Bust	4	0.23	1.27	-1.50	2.90	0.4889
Chest Height Below Bust	5	0.80	1.36	-0.80	3.70	0.0384
Chest Height Below Bust	6	-2.14	1.30	-3.90	0.00	0.0001
Foot Breadth	2	-0.18	0.30	-0.90	0.30	0.0335
Foot Breadth	3	-0.31	0.34	-1.00	0.20	0.0034
Foot Breadth	4	-0.10	0.32	-0.70	0.50	0.2503
Foot Breadth	5	-0.17	0.37	-1.00	0.50	0.1060
Foot Breadth	6	-0.15	0.46	-0.80	0.80	0.2383

### Summary Statistics for the Actual Changes from Baseline (N=15)

Measurement Name	Session	Mean	Standard Deviation	Minimum	Maximum	P-Value
Hand Breadth	2	-0.03	0.17	-0.40	0.30	0.5555
Hand Breadth	3	0.07	0.07	0.00	0.20	0.0031
Hand Breadth	4	0.08	0.17	-0.30	0.30	0.0896
Hand Breadth	5	0.17	0.16	-0.10	0.40	0.0014
Hand Breadth	6	0.09	0.13	-0.10	0.30	0.0170
Hip Breadth	2	0.85	0.78	-0.20	2.20	0.0009
Hip Breadth	3	1.44	0.73	-0.30	2.70	0.0001
Hip Breadth	4	1.37	0.71	0.30	2.60	0.0001
Hip Breadth	5	1.36	0.74	0.10	2.70	0.0001
Hip Breadth	6	0.78	0.86	-0.50	2.30	0.0034
Hip Breadth, Sitting	2	1.03	0.98	-0.10	3.20	0.0011
Hip Breadth, Sitting	3	1.81	0.65	0.90	3.30	0.0001
Hip Breadth, Sitting	4	2.03	0.81	0.60	3.90	0.0001
Hip Breadth, Sitting	5	2.17	0.97	1.10	4.50	0.0001
Hip Breadth, Sitting	6	0.96	1.17	-0.50	2.90	0.0066
Hip Circumference	2	2.95	2.66	-3.10	6.60	0.0007
Hip Circumference	3	4.91	2.19	0.60	9.10	0.0001
Hip Circumference	4	6.04	2.61	-1.30	10.00	0.0001
Hip Circumference	5	7.32	2.28	4.10	12.10	0.0001
Hip Circumference	6	2.37	6.03	-17.60	7.90	0.1505
Knee Height, Sitting	2	0.09	0.44	-0.60	0.90	0.4283
Knee Height, Sitting	3	0.45	0.47	-0.20	1.40	0.0024
Knee Height, Sitting	4	0.52	0.49	-0.20	1.40	0.0010
Knee Height, Sitting	5	0.67	0.38	0.00	1.30	0.0001
Knee Height, Sitting	6	0.46	0.50	-0.40	1.20	0.0029
Patella Top Height	2	-0.13	0.53	-1.10	0.70	0.3477
Patella Top Height	3	0.28	0.78	-0.70	2.00	0.1853
Patella Top Height	4	0.07	0.93	-1.50	1.50	0.7651
Patella Top Height	5	0.35	0.77	-1.20	1.50	0.1038
Patella Top Height	6	0.25	0.72	-1.10	1.50	0.1962
Sitting Height	2	0.23	0.36	-0.60	0.70	0.0256
Sitting Height	3	0.17	0.47	-0.60	0.90	0.1762
Sitting Height	4	0.15	0.57	-0.80	1.40	0.3332
Sitting Height	5	-0.02	0.51	-1.00	0.90	0.8812
Sitting Height	6	-0.49	0.69	-1.60	0.90	0.0160
Stature	2	-0.03	0.41	-0.80	0.70	0.8030
Stature	3	-0.13	0.49	-0.80	1.10	0.3343
Stature	4	-0.23	0.42	-0.70	0.60	0.0487
Stature	5	-0.15	0.48	-0.80	0.80	0.2344
Stature	6	-0.85	0.63	-1.80	0.20	0.0001

### Summary Statistics for the Actual Changes from Baseline (N=15)

Measurement Name	Session	Mean	Standard Deviation	Minimum	Maximum	P-Value
Substernale Height	2	0.39	0.93	-0.80	1.80	0.1304
Substernale Height	3	1.86	1.80	-0.90	4.50	0.0013
Substernale Height	4	1.39	1.90	-2.40	4.50	0.0136
Substernale Height	5	1.49	2.00	-2.30	5.40	0.0122
Substernale Height	6	-1.07	1.35	-2.80	2.40	0.0083
Suprasternale Height	2	0.07	0.52	-0.70	1.30	0.6302
Suprasternale Height	3	0.43	0.61	-0.70	1.40	0.0156
Suprasternale Height	4	0.20	0.67	-0.70	1.20	0.2646
Suprasternale Height	5	0.14	0.68	-1.20	1.20	0.4400
Suprasternale Height	6	-0.63	0.67	-2.00	0.50	0.0026
Tenth Rib Height	2	0.87	1.68	-1.50	4.10	0.0641
Tenth Rib Height	3	2.51	1.38	0.40	5.60	0.0001
Tenth Rib Height	4	2.90	1.08	0.90	4.60	0.0001
Tenth Rib Height	5	3.39	1.68	0.80	6.60	0.0001
Tenth Rib Height	6	-0.31	1.05	-2.30	1.30	0.2775
Thigh Circumference, Proximal	2	1.63	1.65	-2.60	3.80	0.0018
Thigh Circumference, Proximal	3	2.62	1.73	-1.20	5.00	0.0001
Thigh Circumference, Proximal	4	2.95	1.79	-0.10	6.40	0.0001
Thigh Circumference, Proximal	5	3.51	2.03	-0.50	7.60	0.0001
Thigh Circumference, Proximal	6	1.06	1.64	-1.80	3.70	0.0252
Thumbtip Reach, Right	2	-0.21	0.93	-2.50	1.20	0.3918
Thumbtip Reach, Right	3	-0.42	1.42	-3.90	1.20	0.2700
Thumbtip Reach, Right	4	-0.35	1.63	-4.70	2.10	0.4234
Thumbtip Reach, Right	5	-0.61	1.95	-3.80	2.00	0.2424
Thumbtip Reach, Right	6	0.14	1.66	-2.80	2.50	0.7490
Weight	2	10.66	4.19	4.00	18.50	0.0001
Weight	3	18.97	4.57	13.00	31.00	0.0001
Weight	4	22.48	5.12	16.20	36.50	0.0001
Weight	5	29.30	6.89	19.50	49.00	0.0001
Weight	6	7.41	5.30	0.50	19.30	0.0001
Waist Breadth, Omphalion	2	1.30	1.59	-1.20	4.80	0.0070
Waist Breadth, Omphalion	3	2.63	1.72	0.70	5.40	0.0001
Waist Breadth, Omphalion	4	3.23	1.88	0.90	6.40	0.0001
Waist Breadth, Omphalion	5	3.95	1.84	0.50	7.00	0.0001
Waist Breadth, Omphalion	6	2.31	2.21	-1.00	6.30	0.0012
Waist Breadth, Preferred	2	0.95	1.67	-2.10	3.20	0.0443
Waist Breadth, Preferred	3	2.13	1.50	-1.30	4.70	0.0001
Waist Breadth, Preferred	4	2.68	1.35	0.20	5.10	0.0001
Waist Breadth, Preferred	5	3.14	1.54	-0.40	5.50	0.0001
Waist Breadth, Preferred	6	1.57	1.27	0.20	3.90	0.0003



### Summary Statistics for the Actual Changes from Baseline (N=15)

Measurement Name	Session	Mean	Standard Deviation	Minimum	Maximum	P-Value
Waist Circumference, Omphalion	2	10.31	5.00	2.00	19.20	0.0001
Waist Circumference, Omphalion	3	18.77	5.70	8.40	27.80	0.0001
Waist Circumference, Omphalion	4	22.14	6.18	13.10	34.50	0.0001
Waist Circumference, Omphalion	5	27.61	5.33	18.30	38.70	0.0001
Waist Circumference, Omphalion	6	8.84	5.98	-0.10	17.20	0.0001
Waist Circumference, Preferred	2	7.75	4.89	0.00	14.30	0.0001
Waist Circumference, Preferred	3	14.33	4.47	7.80	23.60	0.0001
Waist Circumference, Preferred	4	17.04	4.85	9.70	26.90	0.0001
Waist Circumference, Preferred	5	20.86	5.59	7.70	29.00	0.0001
Waist Circumference, Preferred	6	6.87	3.90	-0.40	15.20	0.0001
Waist Depth, Omphalion	2	4.32	2.04	0.40	8.40	0.0001
Waist Depth, Omphalion	3	8.00	2.13	4.10	12.10	0.0001
Waist Depth, Omphalion	4	9.65	2.16	6.30	14.20	0.0001
Waist Depth, Omphalion	5	12.33	1.95	9.30	16.70	0.0001
Waist Depth, Omphalion	6	2.22	2.20	-1.10	5.70	0.0016
Waist Depth, Preferred	2	3.23	1.67	0.00	5.70	0.0001
Waist Depth, Preferred	3	6.24	1.73	3.30	9.90	0.0001
Waist Depth, Preferred	4	7.66	1.74	4.50	10.30	0.0001
Waist Depth, Preferred	5	9.31	2.40	3.50	12.60	0.0001
Waist Depth, Preferred	6	1.95	1.49	-0.10	4.80	0.0002
Waist Height, Omphalion	2	-0.33	1.09	-3.10	1.40	0.2637
Waist Height, Omphalion	3	-0.80	1.98	-3.40	4.90	0.1399
Waist Height, Omphalion	4	-1.49	1.74	-5.20	2.10	0.0052
Waist Height, Omphalion	5	-2.05	1.69	-4.60	2.30	0.0003
Waist Height, Omphalion	6	-0.99	1.09	-3.20	0.10	0.0035
Waist Height, Preferred	2	1.36	3.01	-2.10	6.80	0.1022
Waist Height, Preferred	3	3.37	4.00	-5.20	8.10	0.0057
Waist Height, Preferred	4	2.17	5.80	-13.10	11.60	0.1690
Waist Height, Preferred	5	1.64	6.54	-13.80	8.80	0.3479
Waist Height, Preferred	6	-0.32	1.67	-2.90	2.90	0.4701

### Box and Whisker Plots for the Changes from Baseline

The following plots (Figures 13-19) display part of the information given in Table 16. These plots give, per session, the mean change from Session 1 (earliest stage of pregnancy, or baseline data) for each dimension. The box encloses the mean plus or minus one standard deviation, containing roughly two-thirds of subject changes. The whiskers extend, showing the minimum and maximum values of change from Session 1.

For example, consider Ankle Circumference: At Session 3, the mean change from Session 1 was +0.15 cm ( $\approx 0.2$  cm), with a variance of 0.81 cm. The minimum and maximum changes (from Session 1) were -1.5 cm and 1.4 cm respectively.

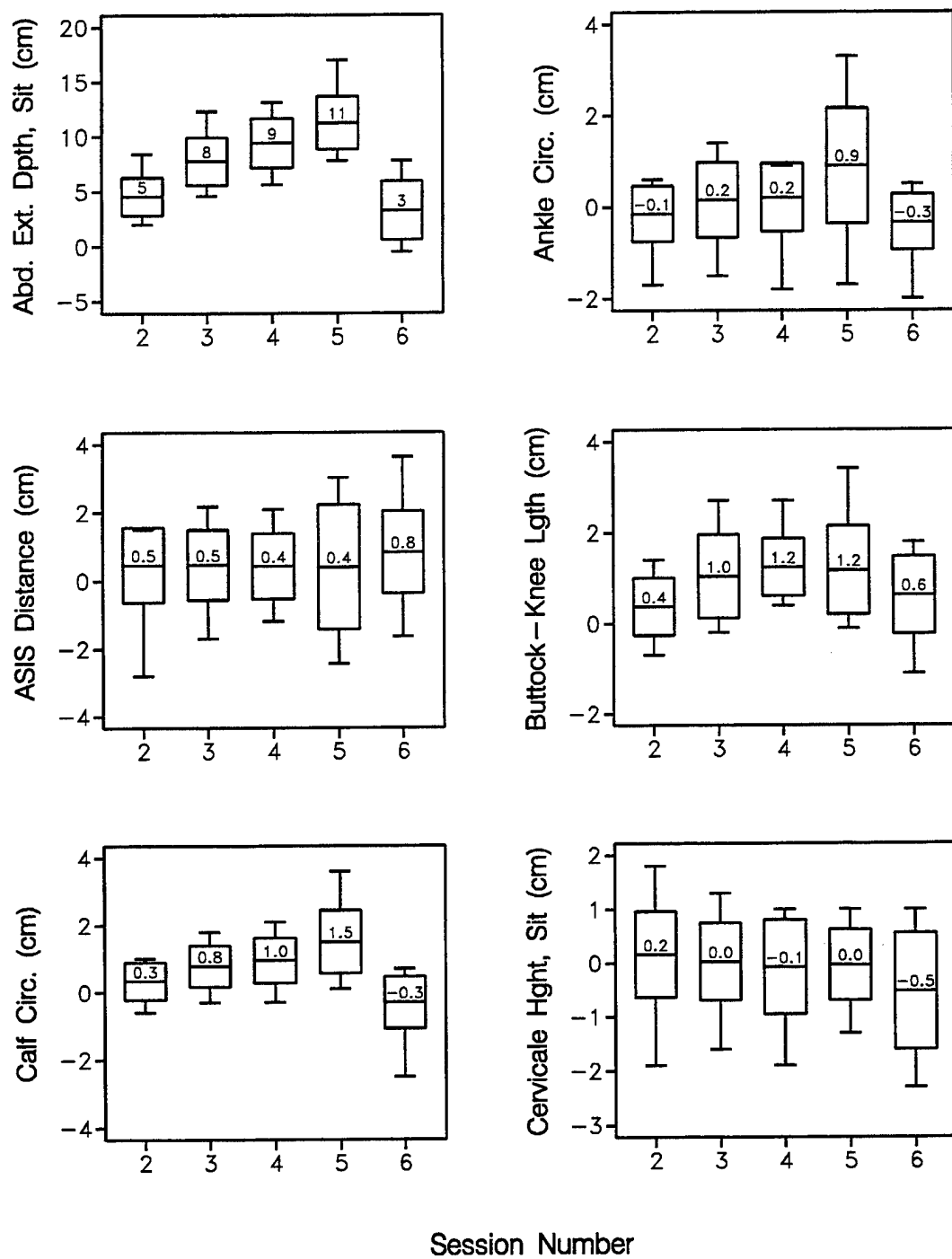


Figure 13. Box and Whisker Plots for Change from Session 1(N=15).

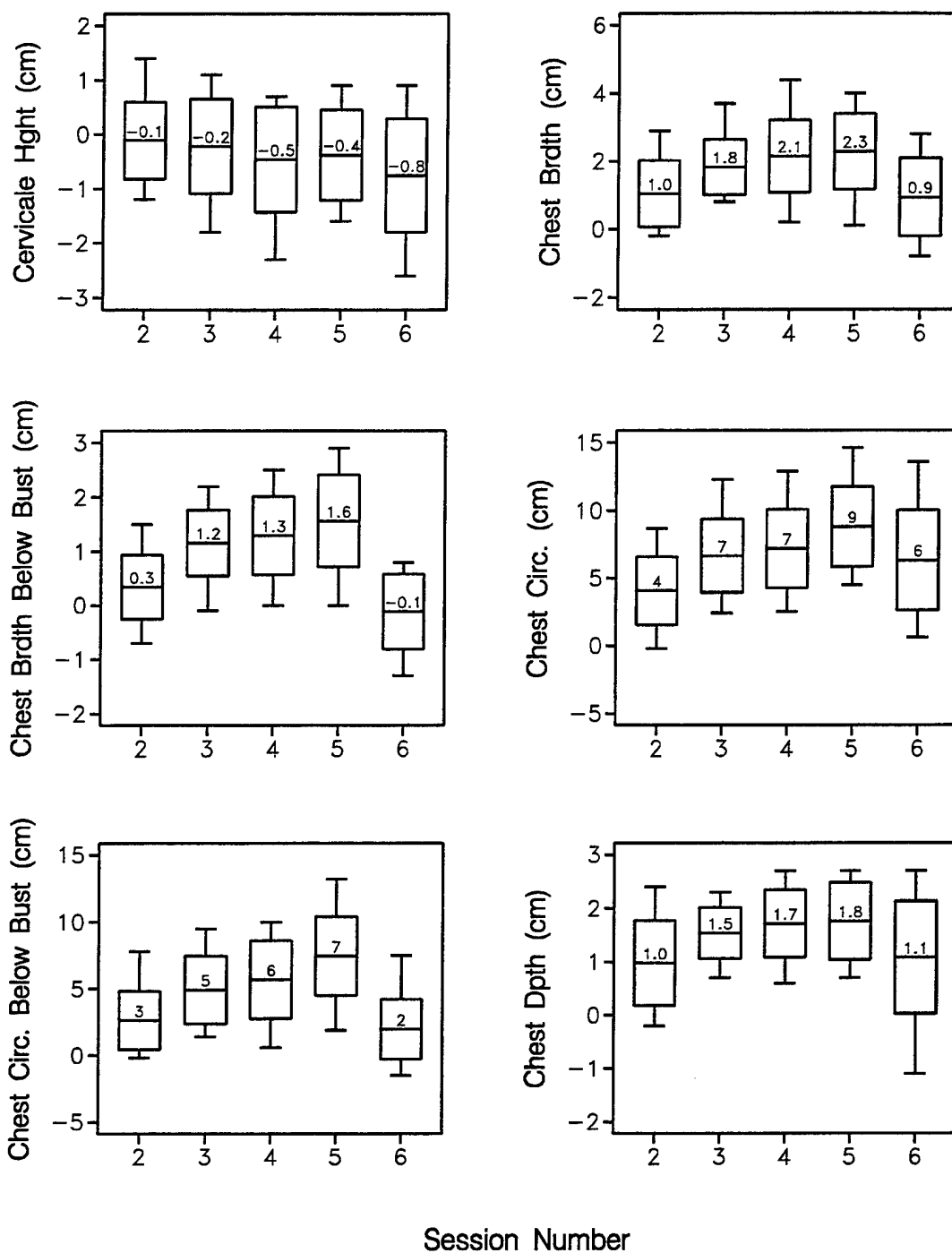


Figure 14. Box and Whisker Plots for Change from Session 1 Continued (N=15).

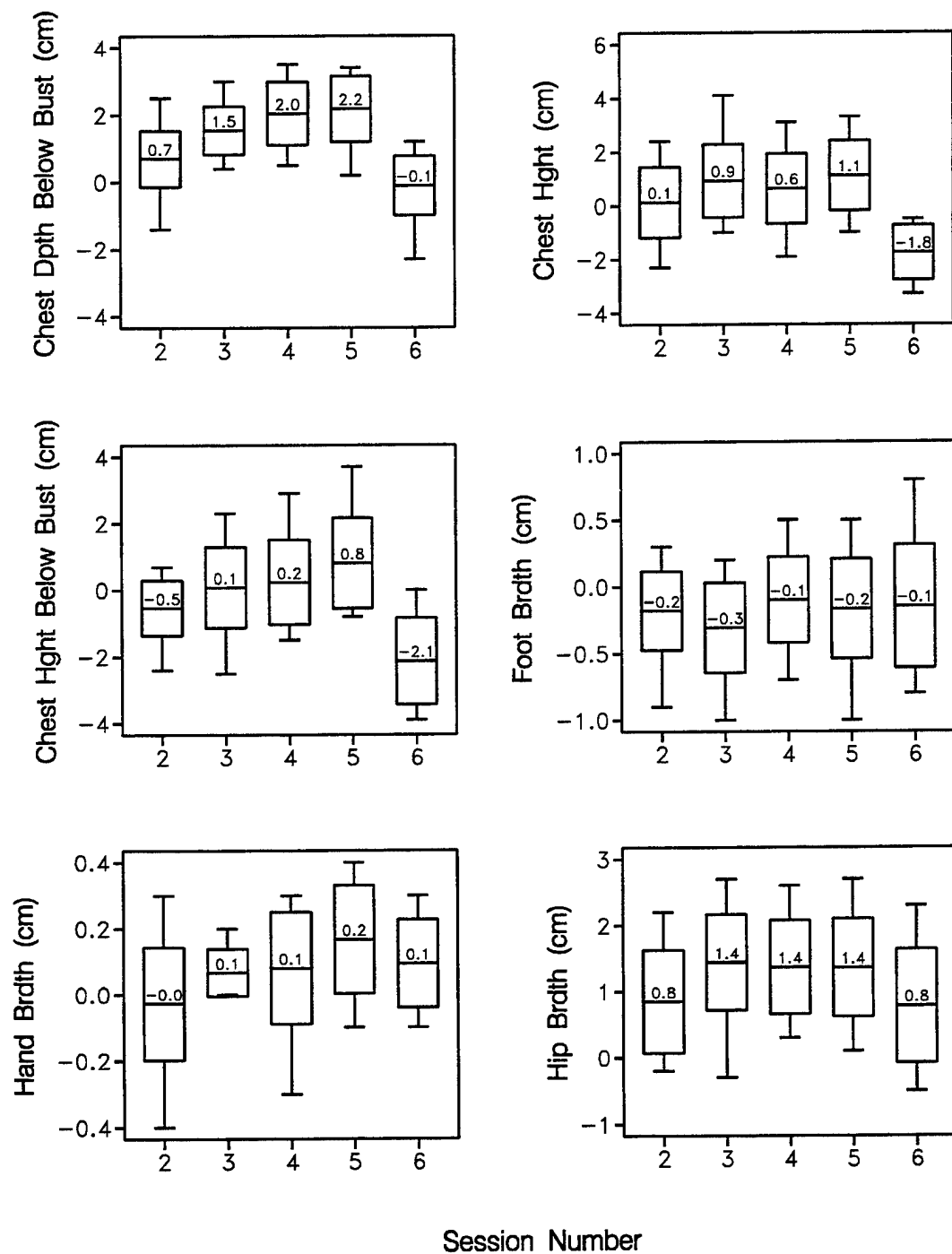


Figure 15. Box and Whisker Plots for Change from Session 1 Continued (N=15).

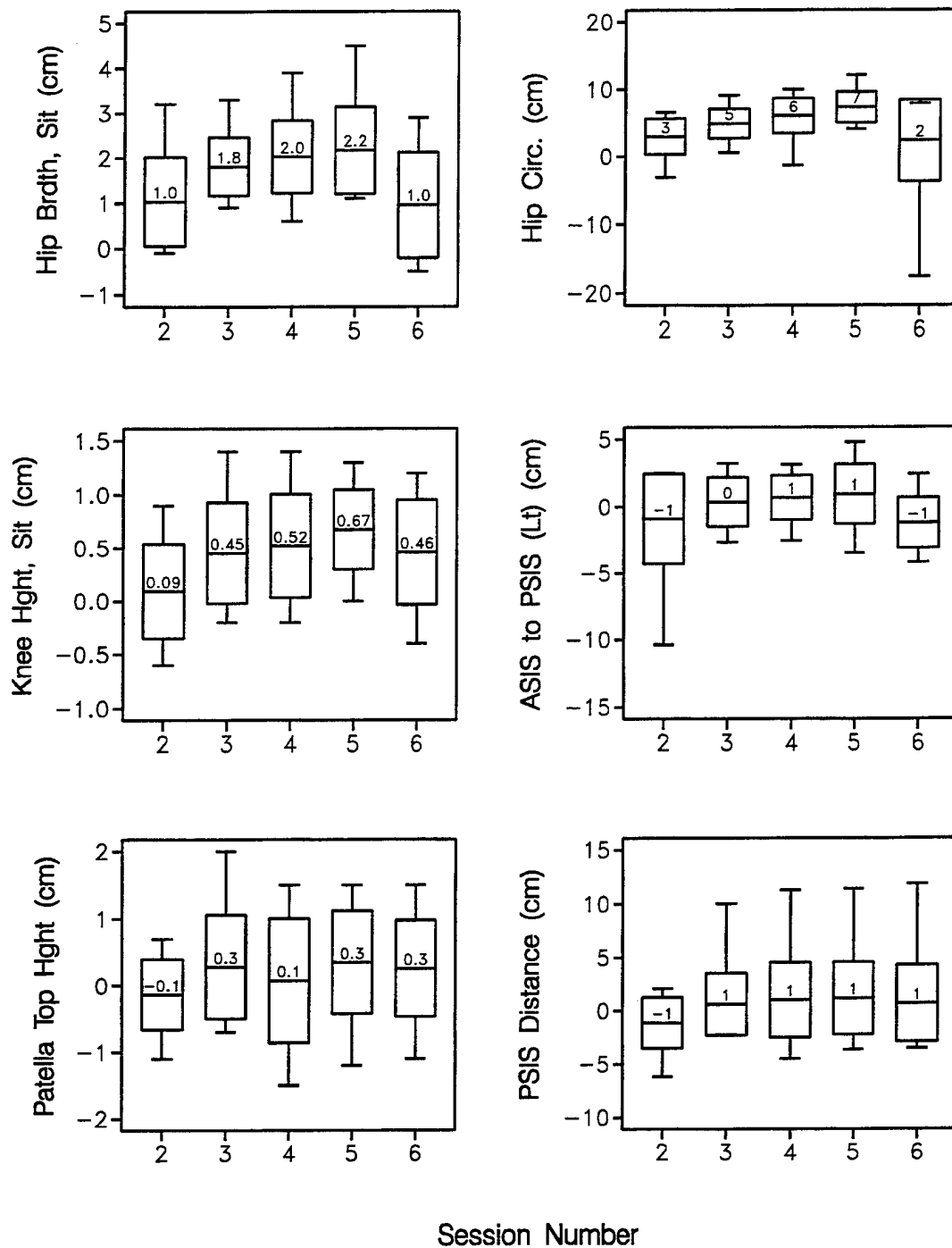
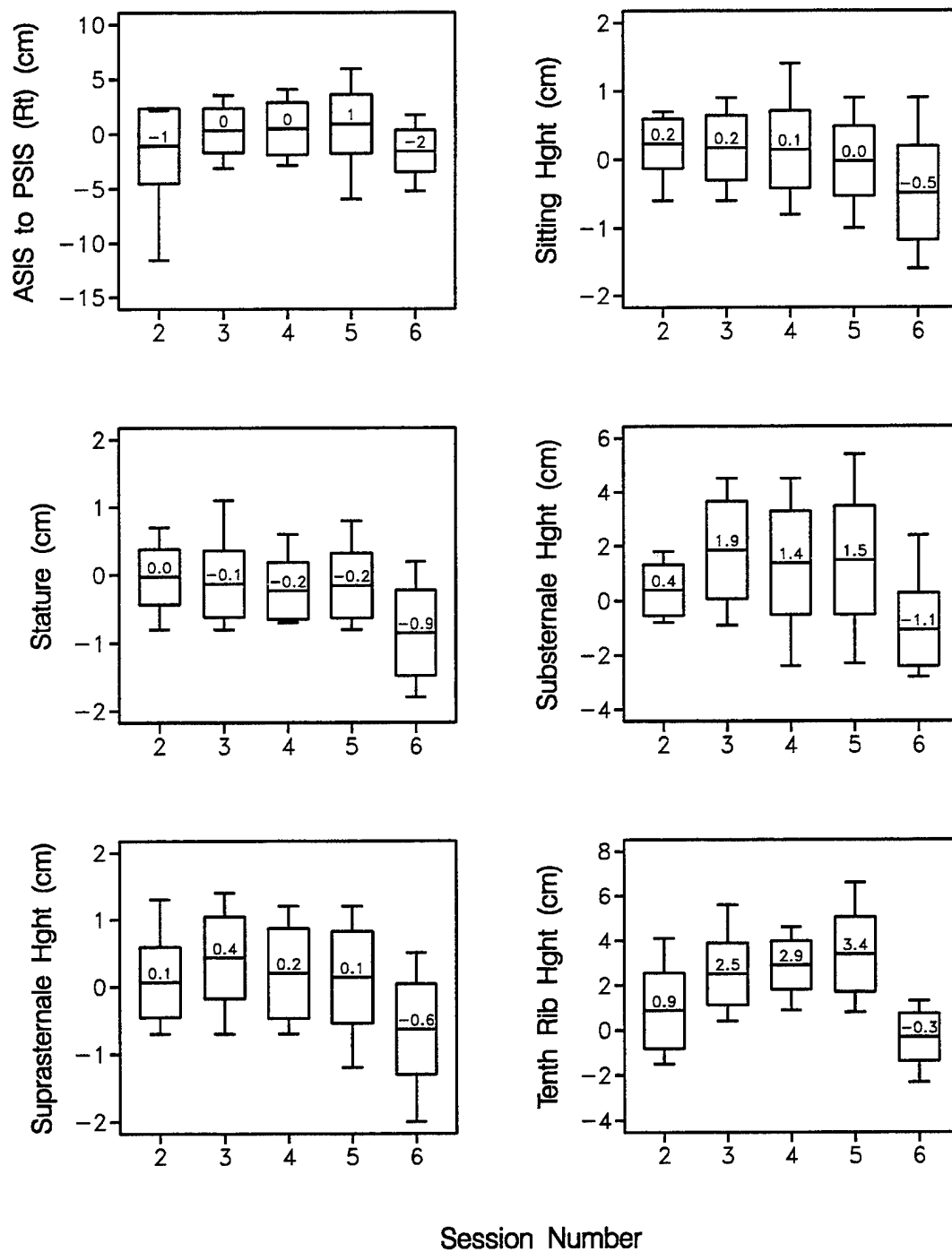


Figure 16. Box and Whisker Plots for Change from Session 1 Continued (N=15).



**Figure 17. Box and Whisker Plots for Change from Session 1 Continued (N=15).**

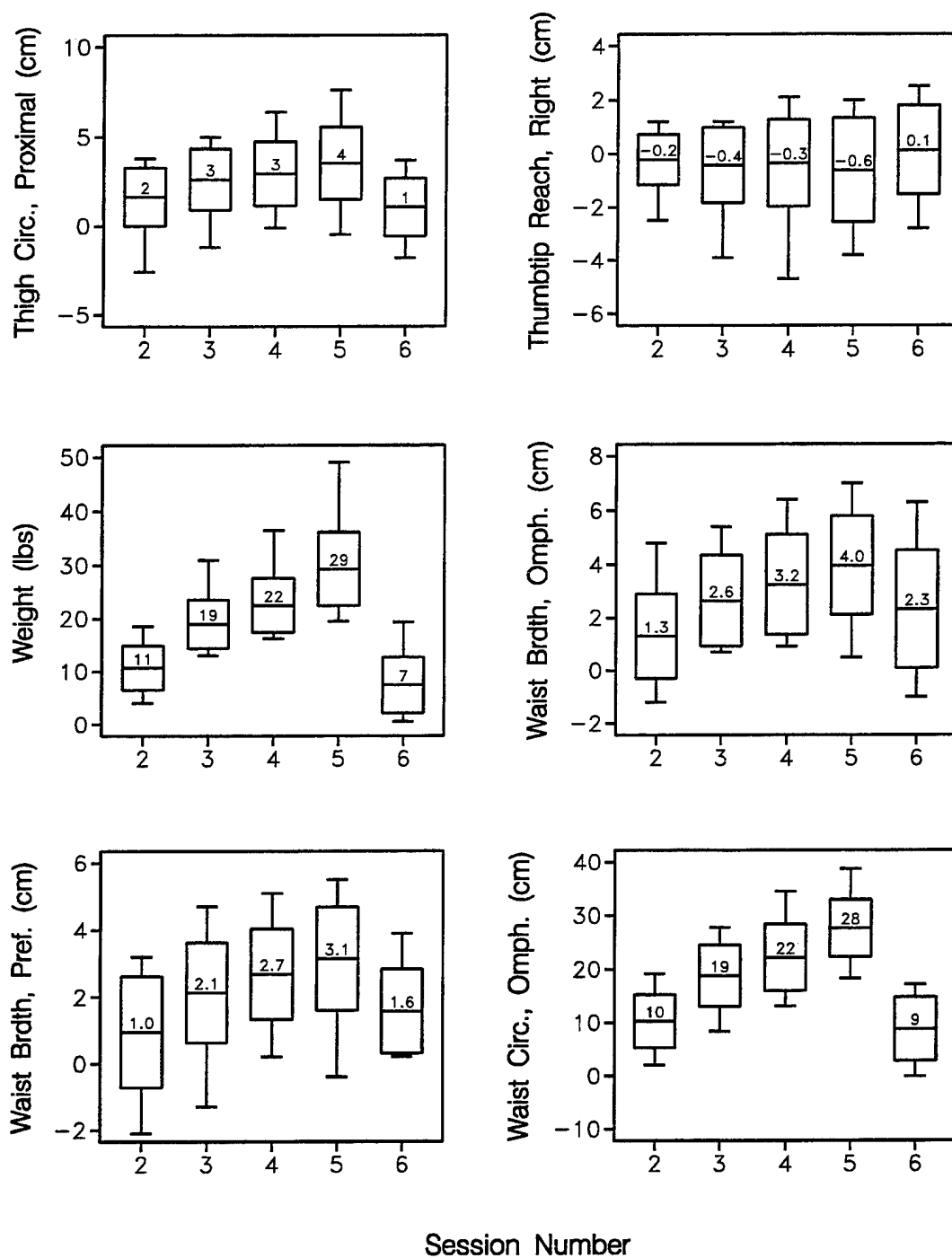


Figure 18. Box and Whisker Plots for Change from Session 1 Continued (N=15).



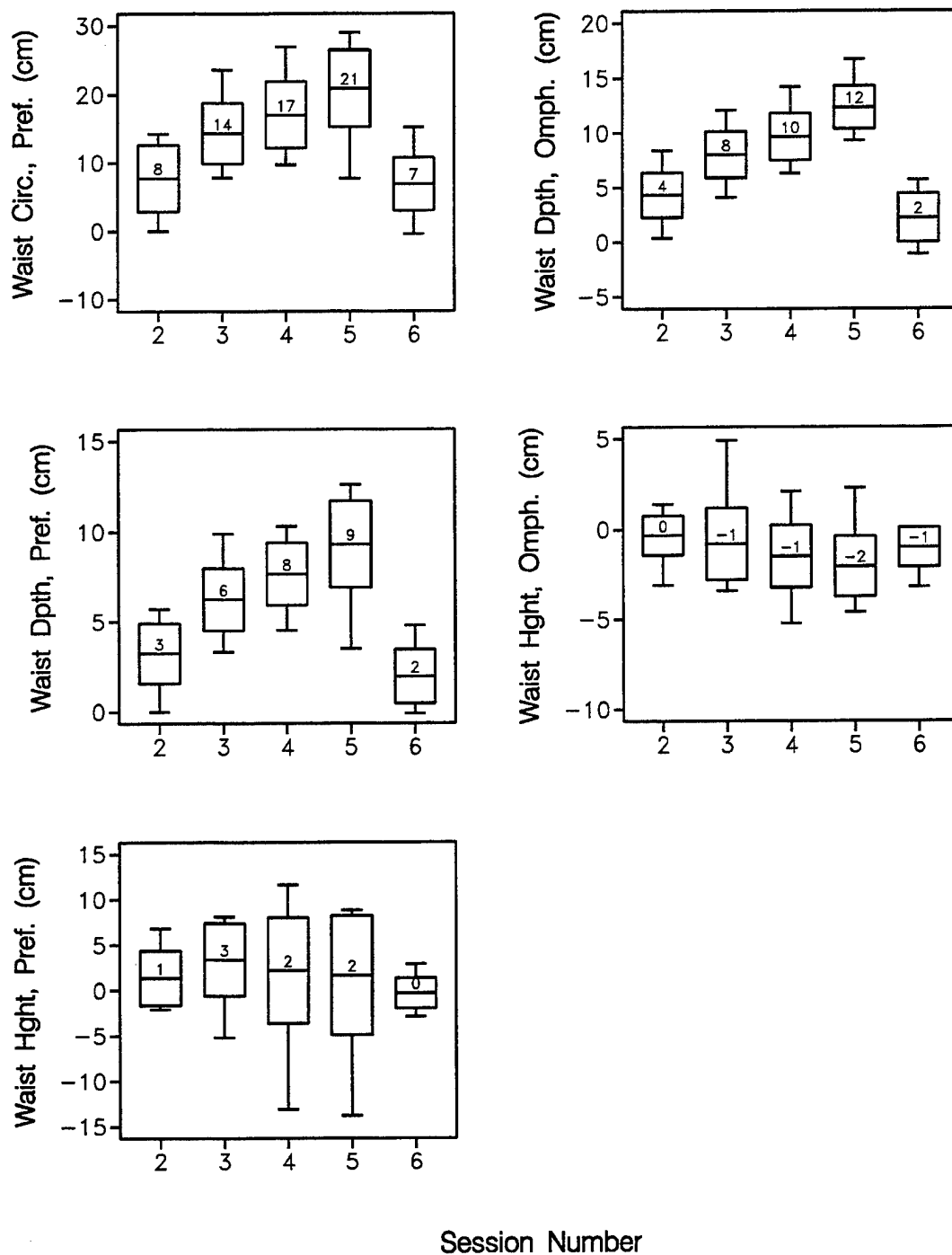


Figure 19. Box and Whisker Plots for Change from Session 1 Continued (N=15).

## Electronic Data

### Radial Difference Mapping

The 3-D anthropometric data were analyzed using INTEGRATE (see Appendix J for a description of INTEGRATE), a software tool developed by Sytronics, Inc. for the CARD Laboratory and used for the visualization, analysis, and manipulation of scan data. One of INTEGRATE's key features, Radial Difference Mapping, visually and quantitatively demonstrates the relationship of one surface to another. Given two scans, INTEGRATE calculated the regions of differences along each radial value from the first scan to a second scan. These differences are shown as a *Radial Difference Map (RDM)*.

Subjects were scanned in both a standing and seated posture to acquire the contours representing the shape of the body. The second, third, fourth, fifth, and sixth standing scans were aligned with the respective subject's first scan (or baseline scan) using a surface matching technique. The scans were filled by interpolation. Next, the scans were placed in a common coordinate system, distances were calculated between the surfaces along each radius, and regions of differences (e.g. 5 mm, 10 mm) were identified. The five resulting RDMs indicated the amount of shape change a subject undergoes at various stages in pregnancy.

### Euclidean Distance Matrix Analysis (EDMA)

*Euclidean Distance Matrix Analysis (EDMA)* is a coordinate free approach to the analysis of form through the use of homologous landmarks. For a detailed description of EDMA, see Lele (1991) and Lele and Richtsmeier (1991). EDMA studies the change in the Euclidean distances between all landmarks. Due to the assumption of homogeneity, only the 15 subjects who completed all six sessions were included in the EDMA. Additionally, the 17 landmarks which were visible and common to these 15 subjects and their scans were used. A list of those landmarks is given in Table 17.

Using the scan data, the 3-D XYZ coordinate locations of the landmarks were recorded. A matrix of distances between all landmarks, called a *Euclidean distance matrix (EDM)* or *form matrix (F(X))*, was created for each scan. (Thus, there are six EDMs for each subject.) These distances between the landmarks were calculated using

the Euclidean distance formula (1) which is the distance from the  $i^{\text{th}}$  landmark to the  $j^{\text{th}}$  landmark. Note that the distances, not the coordinates, are used in the analysis.

$$d(i,j) = \sqrt{(x_j - x_i)^2 + (y_j - y_i)^2 + (z_j - z_i)^2} \quad (1)$$

**Table 17. Landmarks Used in EDMA.**

Landmark Number	Name
1	Cervicale
2	Cervicale -10
3	Cervicale -20
4	Cervicale -30
5	Cervicale -40
6	PSIS Left
7	PSIS Right
8	Suprasternale
9	Bustpoint Left
10	Bustpoint Right
11	Substernale
12	Tenth Rib Left
13	Tenth Rib Right
14	Waist, Preferred (Front)
15	Waist, Omphalion (Front)
16	ASIS Left
17	ASIS Right

The EDM is the matrix where the  $(i,j)$  entry is simply  $d(i,j)$  as given by formula (1). An example is shown in Figure 20. If someone was interested in the distance from the second landmark to the seventeenth landmark, the  $(2,17)$  entry in the EDM would be the answer. Since the distance from the  $i^{\text{th}}$  landmark to the  $j^{\text{th}}$  landmark is the same as the distance from the  $j^{\text{th}}$  landmark to the  $i^{\text{th}}$  landmark, the EDM is a symmetric matrix. Also, the distance from a landmark to itself is zero, so the diagonal is all zeroes. This can easily be seen in Figure 20.

$$F(X) = \begin{bmatrix} d(1,1) & d(1,2) & d(1,3) & \cdots & d(1,17) \\ d(2,1) & d(2,2) & d(2,3) & \cdots & d(2,17) \\ d(3,1) & d(3,2) & d(3,3) & \cdots & d(3,17) \\ \vdots & \vdots & \vdots & \ddots & \vdots \\ d(17,1) & d(17,2) & d(17,3) & \cdots & d(17,17) \end{bmatrix}$$

**Figure 20. Example of Euclidean Distance Matrix (EDM).**

Next, a *form difference matrix (FDM)*, denoted  $D(X,Y)$ , was computed by taking the ratio of each element of one form matrix ( $F(X)$ ) to another ( $F(Y)$ ). The  $(i,j)$  element of the FDM is the  $(i,j)$  element of  $F(X)$  divided by the  $(i,j)$  element of  $F(Y)$ , see formula (2). Note that for this computation, the division of  $0 / 0$  is defined to be 0. Since

$$D(X,Y) = \frac{F_{i,j}(X)}{F_{i,j}(Y)} \quad (2)$$

$D(X,Y)$  is a symmetric matrix with zero diagonal, only the upper diagonal part is necessary to study the form difference.

Formula (2) shows the differences in distances between sessions can be viewed as ratios. Any ratio smaller than 1 means that the distance in  $F(X)$  between the  $i^{\text{th}}$  and the  $j^{\text{th}}$  landmarks is smaller than that distance in  $F(Y)$ . Similarly, any ratio larger than 1 indicates the distance in  $F(X)$  is larger than the distance in  $F(Y)$ . The ratios from these FDMs which are “substantially larger or substantially smaller than 1” (Lele and Richtsmeier, 1991) are the ratios of interest which denote the areas of the greatest amount of change. Of course, the interpretation of “substantial” is application dependent.

FDMs were calculated for each subject as form differences from one session to another. All sessions were compared in two-way combinations. The FDMs were all calculated as the change from an earlier session to a later session. The denominator in formula (2) is the earlier session. Ratios can be easily understood as a percent change of

the distance in the earlier session. For example, if a ratio in the FDM from Session 1 to Session 2 (D(2,1)) is 1.22, then the distance between those two landmarks was 22% larger for Session 2 than for Session 1.

Because all pairs of sessions were used, each subject had 15 FDMs. If the FDM was "almost" a matrix of 1s, then the two forms (size and shape) were equal. If the FDM was "almost" a matrix of constants, then the two shapes were equal, but size varied. The FDMs for all subjects were averaged together by session pair to determine an average or mean change between those sessions.

Interpretation of the significance of these changes depends on the application. Since this study should have a broad range of application, all of the ratios from the average FDMs are given in Appendix K for future reference. For summary purposes now, interpretations of "substantially different from 1" (given in Table 18) were chosen for the different session comparisons.

**Table 18. Critical Values for EDMA.**

SESSION PAIRS	CRITICAL VALUES
Consecutive Sessions; Session 1 to 6	LE 0.90 or GE 1.10
Session 2 to 6	LE 0.85 or GE 1.15
Session 1 to 3 Session 2 to 4 Session 3 to 5 Session 3 to 6	LE 0.80 or GE 1.20
Session 4 to 6	LE 0.75 or GE 1.25
Session 1 to 4 Session 2 to 5	LE 0.70 or GE 1.30
Session 1 to 5	LE 0.65 or GE 1.35
LE = Less than or equal to GE = Greater than or equal to	

When distances are calculated from a landmark near the midsagittal plane to landmarks which occur on both the left and right (paired landmarks), the analyst expects to see symmetry in the distances and ratios. However, it is possible that the midsagittal landmarks were slightly skewed to one side. Small departures from symmetry should be expected.

## RESULTS

### Traditional Anthropometric Data Analysis Results

#### Individual Changes

Figures 21-27 show each subject's change from Session 1 over the entire period of pregnancy until post-delivery (Session 6). It gives the reader an idea of how different women change from Session 1 to Session 6. Most of the dimensions show that most subjects follow a similar trend; only a few deviate slightly. The plots include the 15 subjects who completed all six data collection sessions.

#### Overall Trend Analysis

A trend analysis using Repeated Measures *Generalized Linear Model (GLM)* was performed on each anthropometric measurement to see how a dimension changed during the course of pregnancy. Only Session 1 through Session 5 (for the 15 subjects who completed all six data collection sessions) were included in the GLM, because Session 6 is the post-delivery session. The highest order polynomial that was significant ( $p\text{-value} \leq 0.05$ ) is identified on the graphs (Figures 28-34).

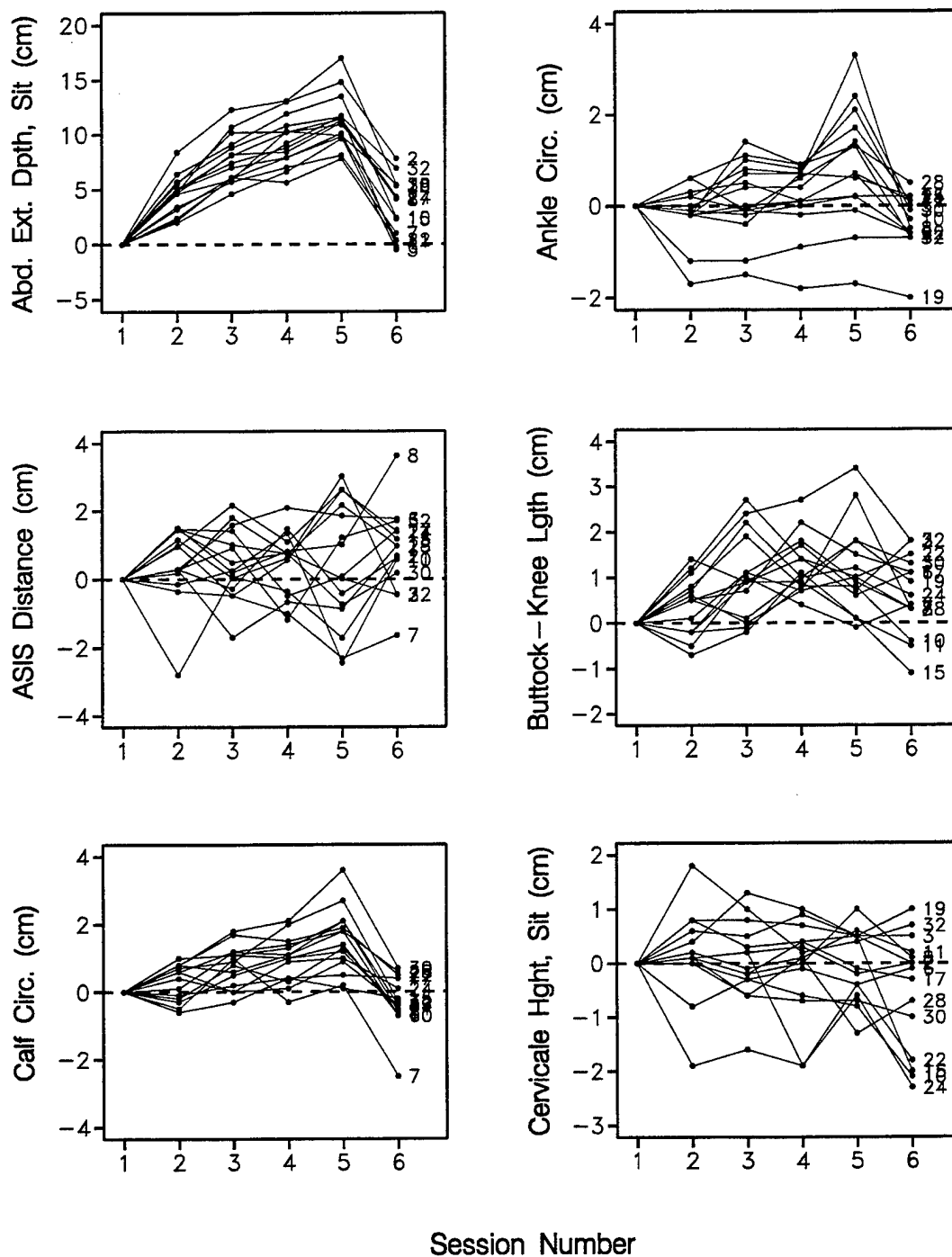


Figure 21. Change from Session 1 for Each Subject (N=15).

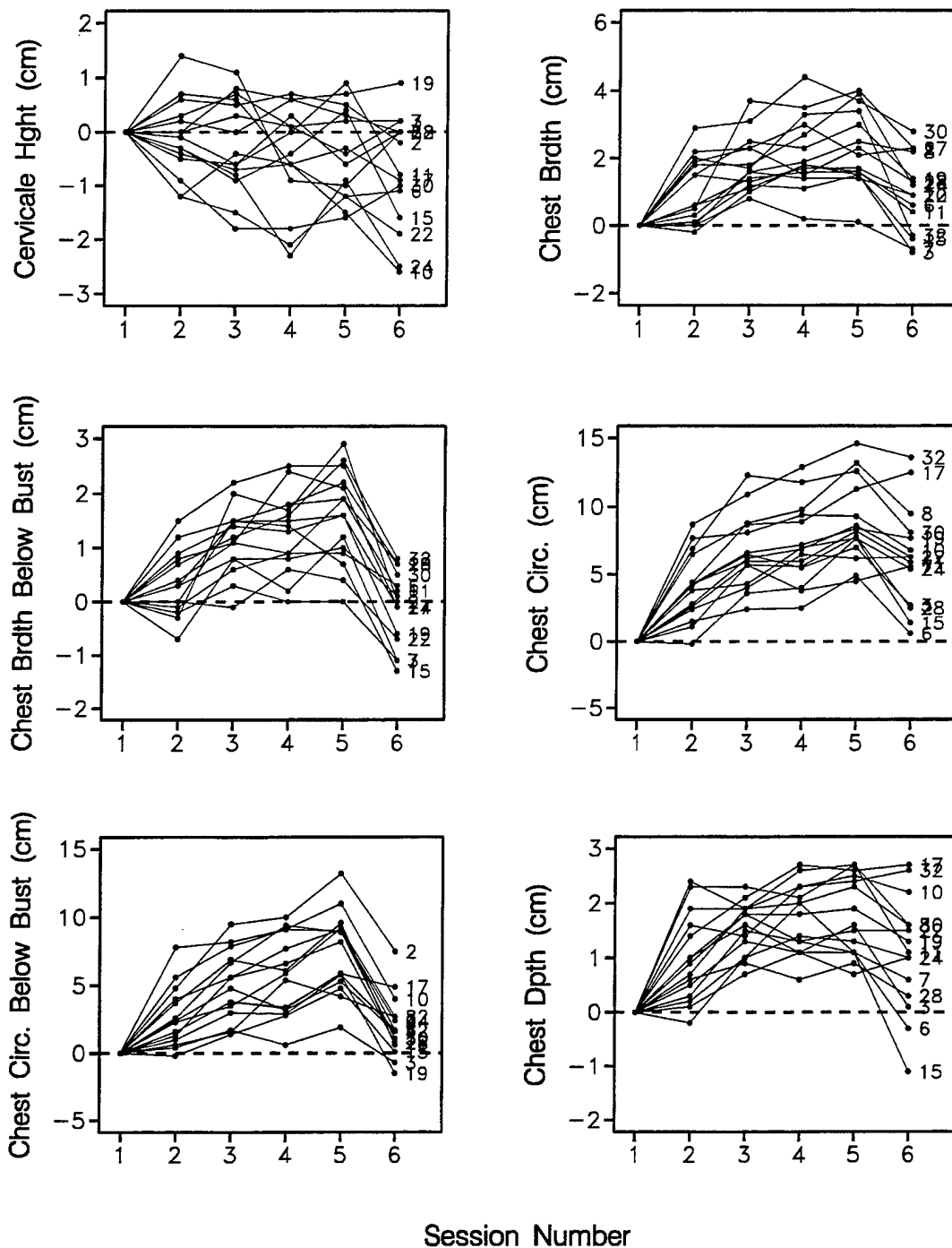


Figure 22. Change from Session 1 for Each Subject Continued (N=15).



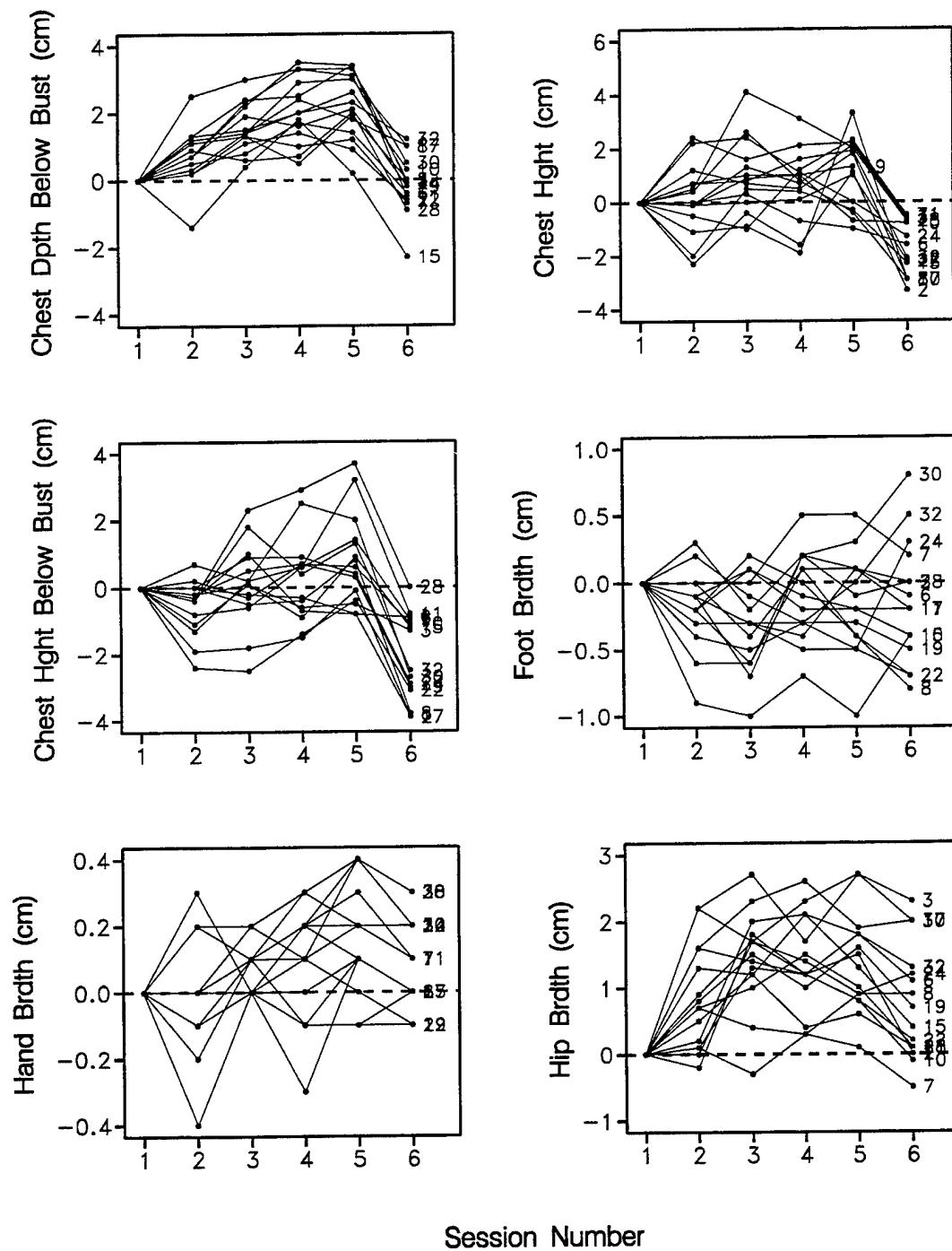


Figure 23. Change from Session 1 for Each Subject Continued (N=15).

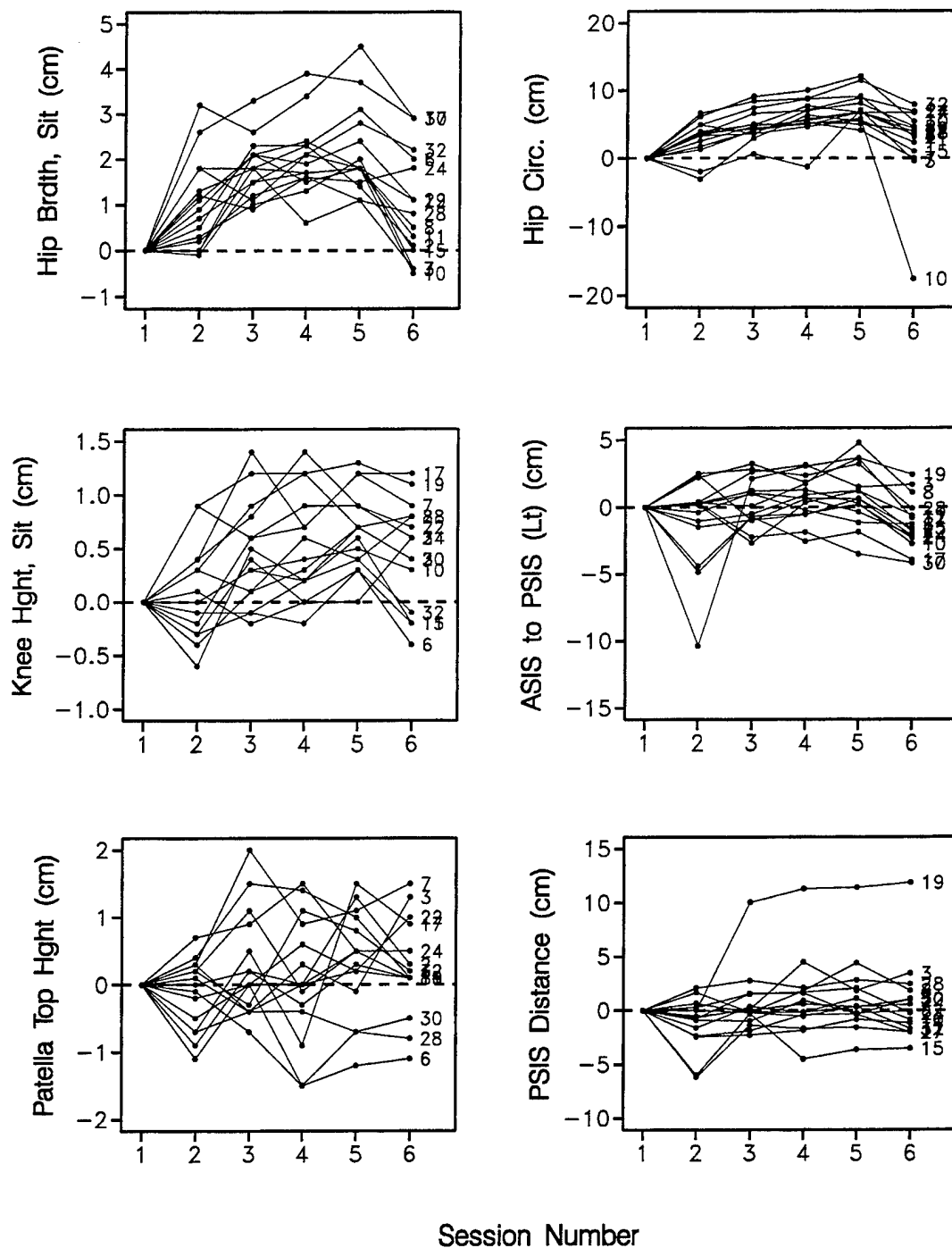


Figure 24. Change from Session 1 for Each Subject Continued (N=15).

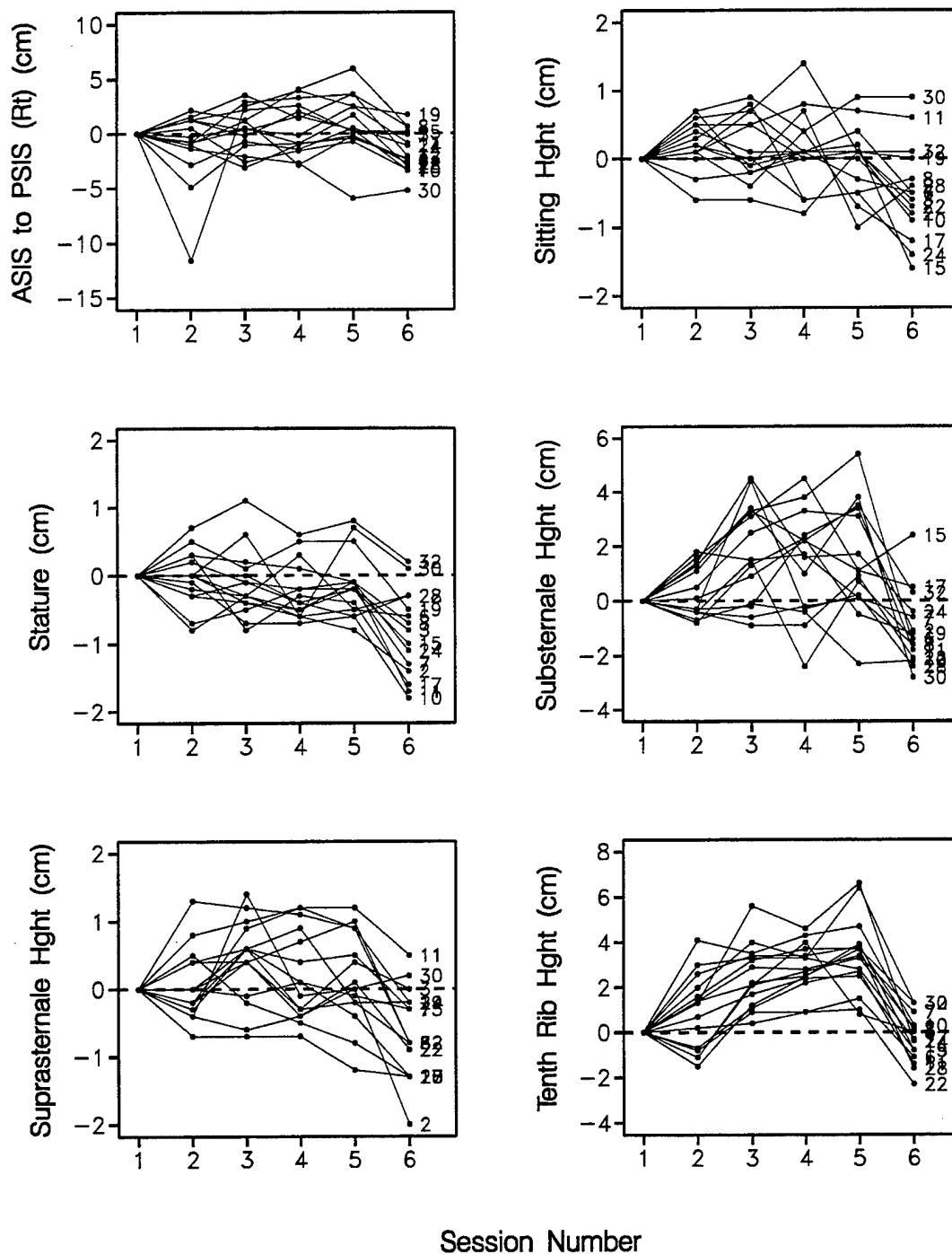


Figure 25. Change from Session 1 for Each Subject Continued (N=15).

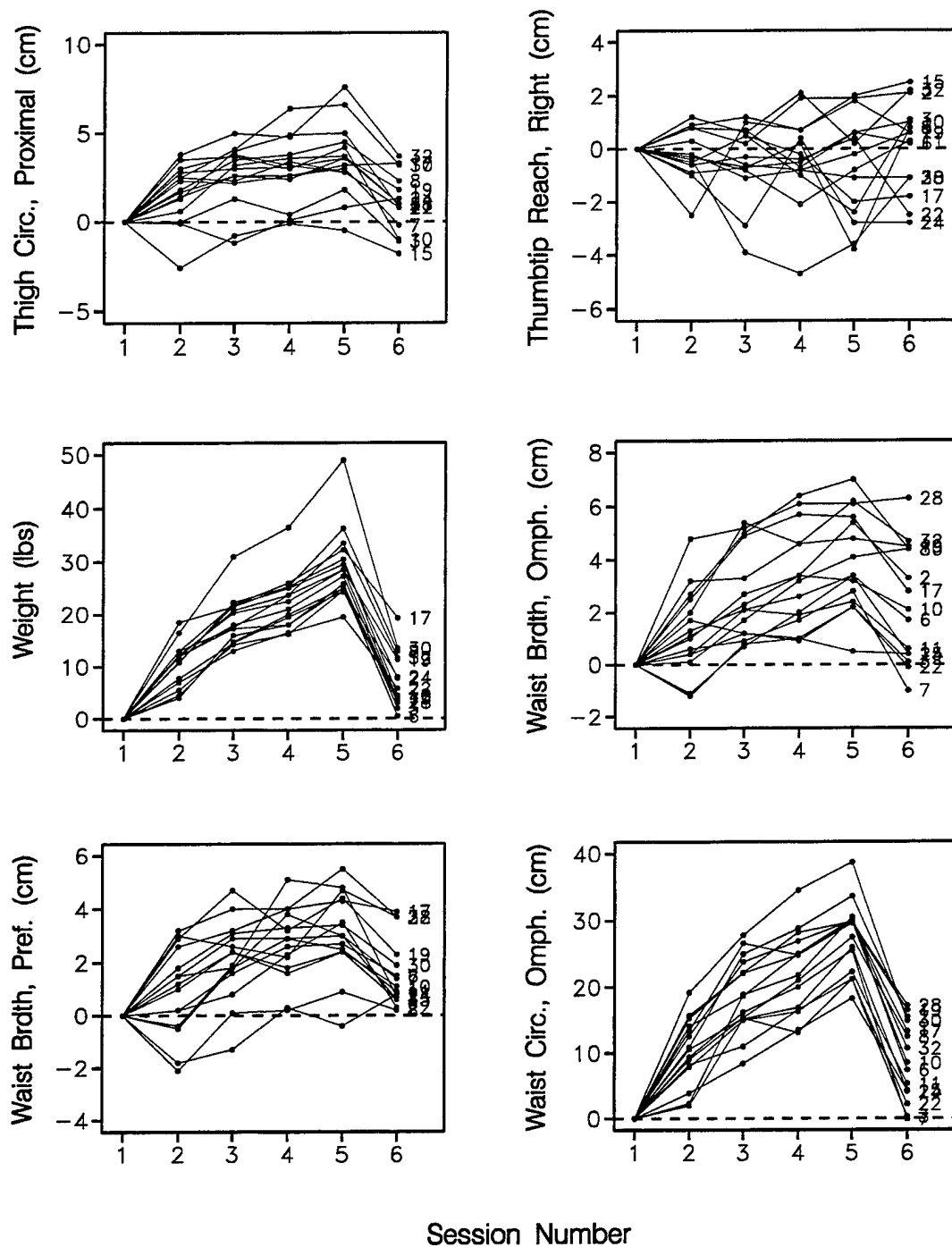


Figure 26. Change from Session 1 for Each Subject Continued (N=15).

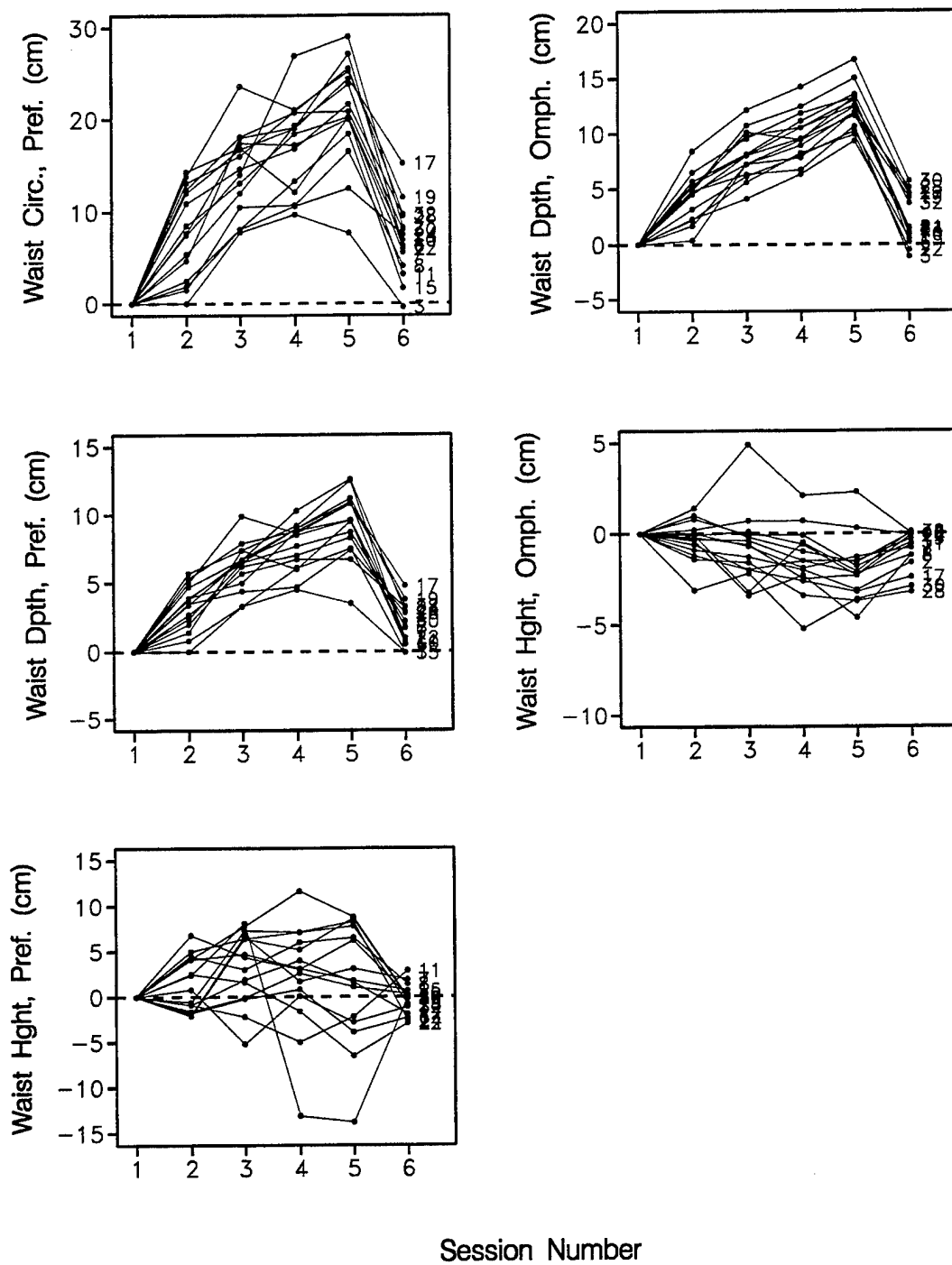


Figure 27. Change from Session 1 for Each Subject Continued (N=15).

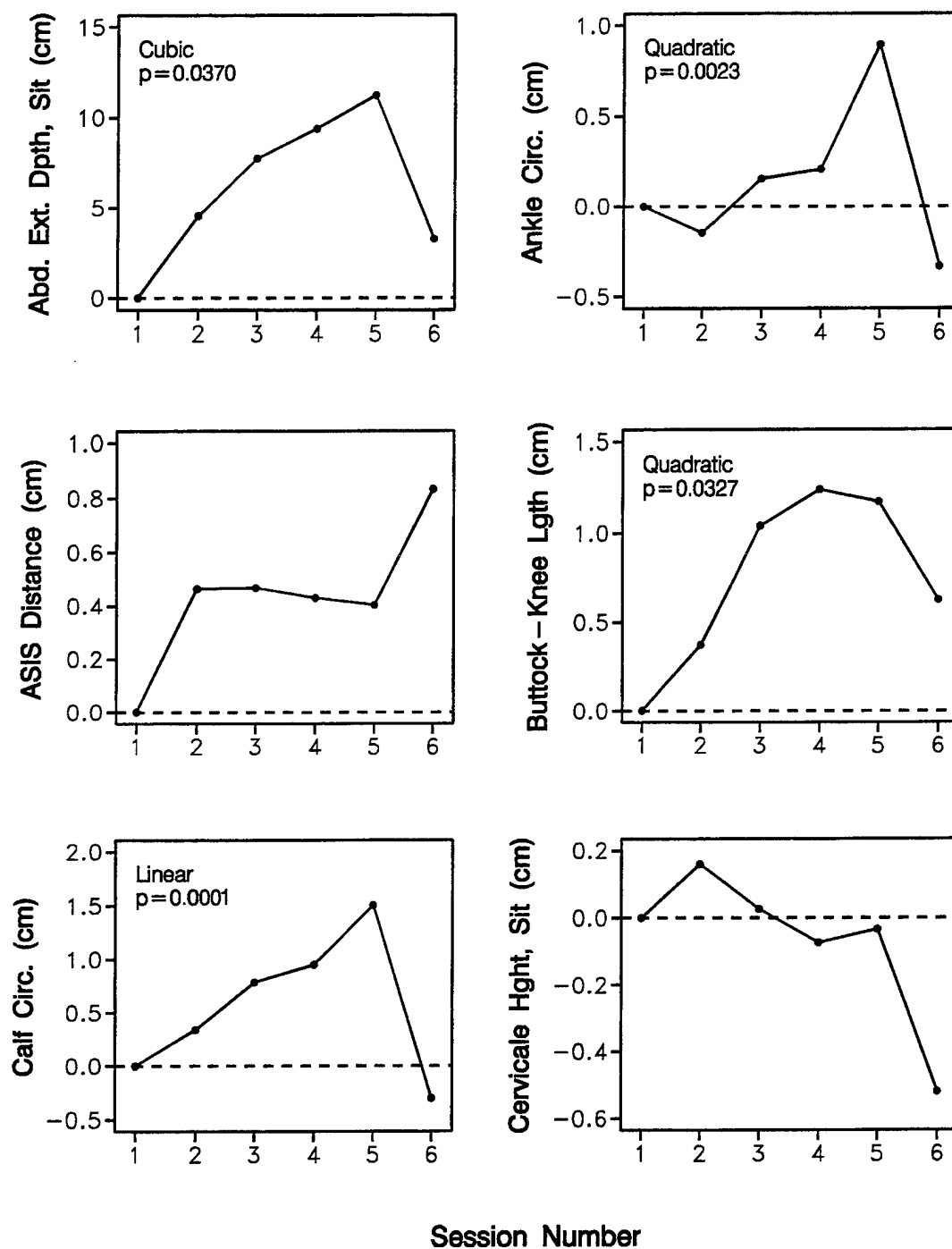


Figure 28. Change from Session 1 Averaged Across Subjects (N=15).

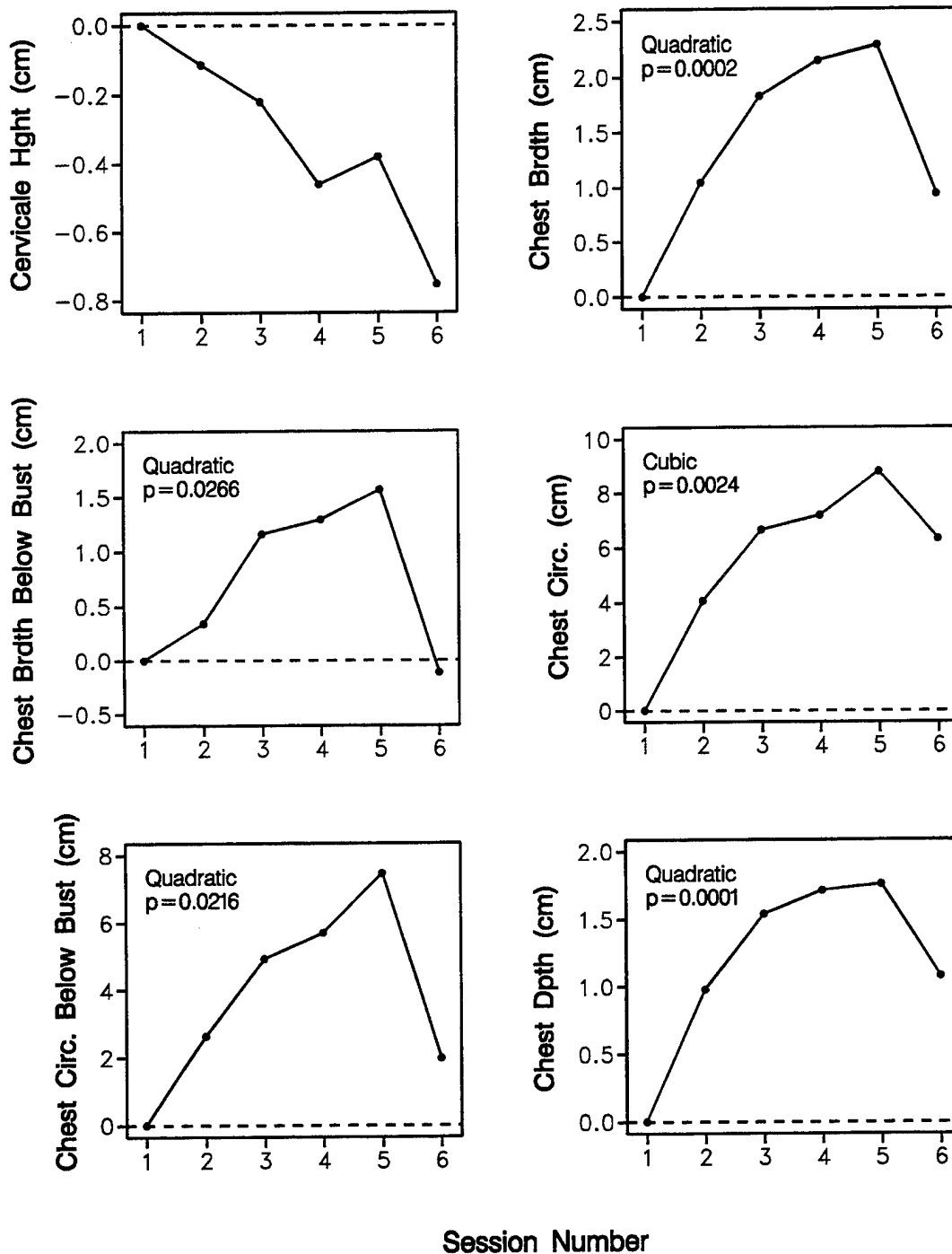
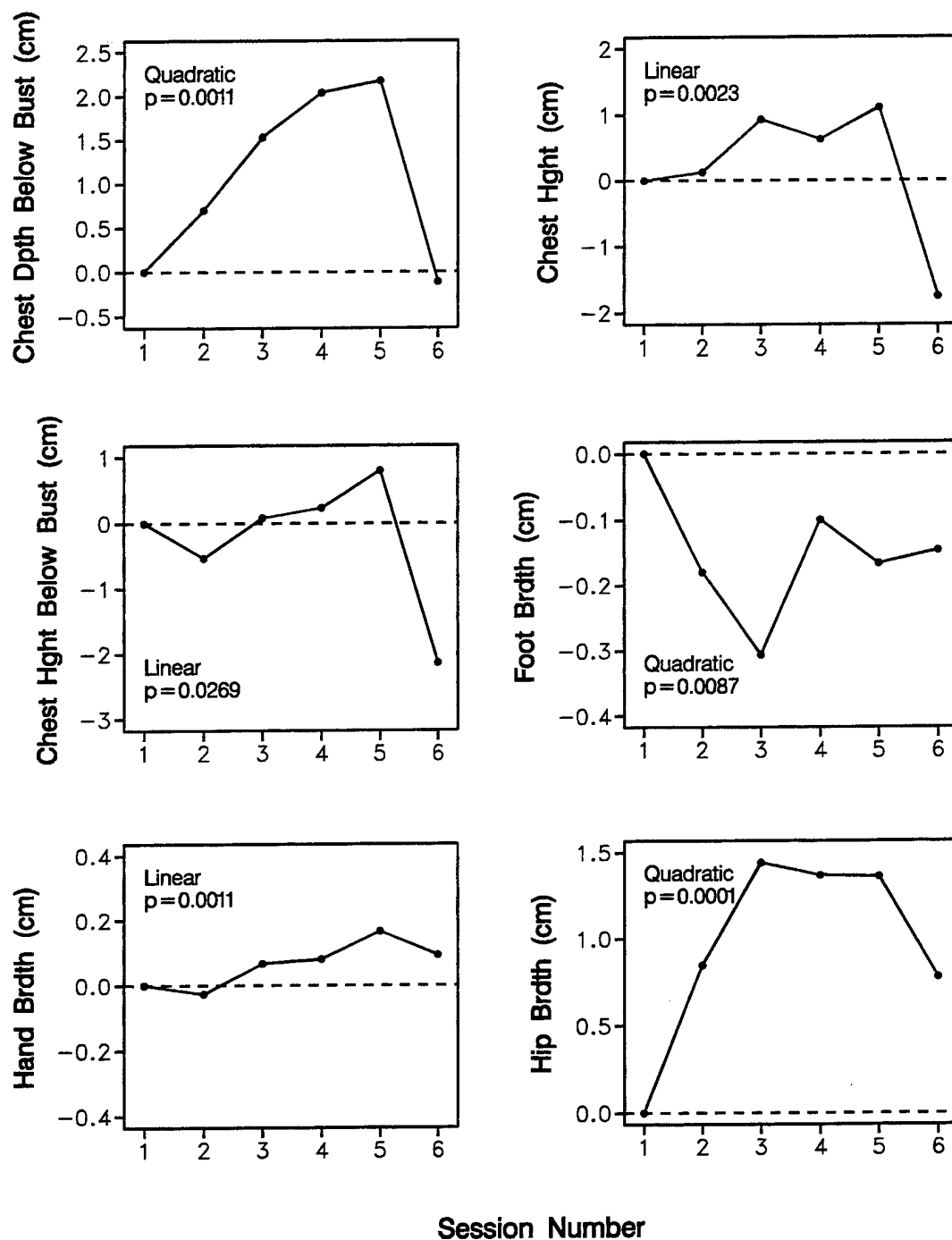


Figure 29. Change from Session 1 Averaged Across Subjects (N=15).



**Figure 30. Change from Session 1 Averaged Across Subjects (N=15).**



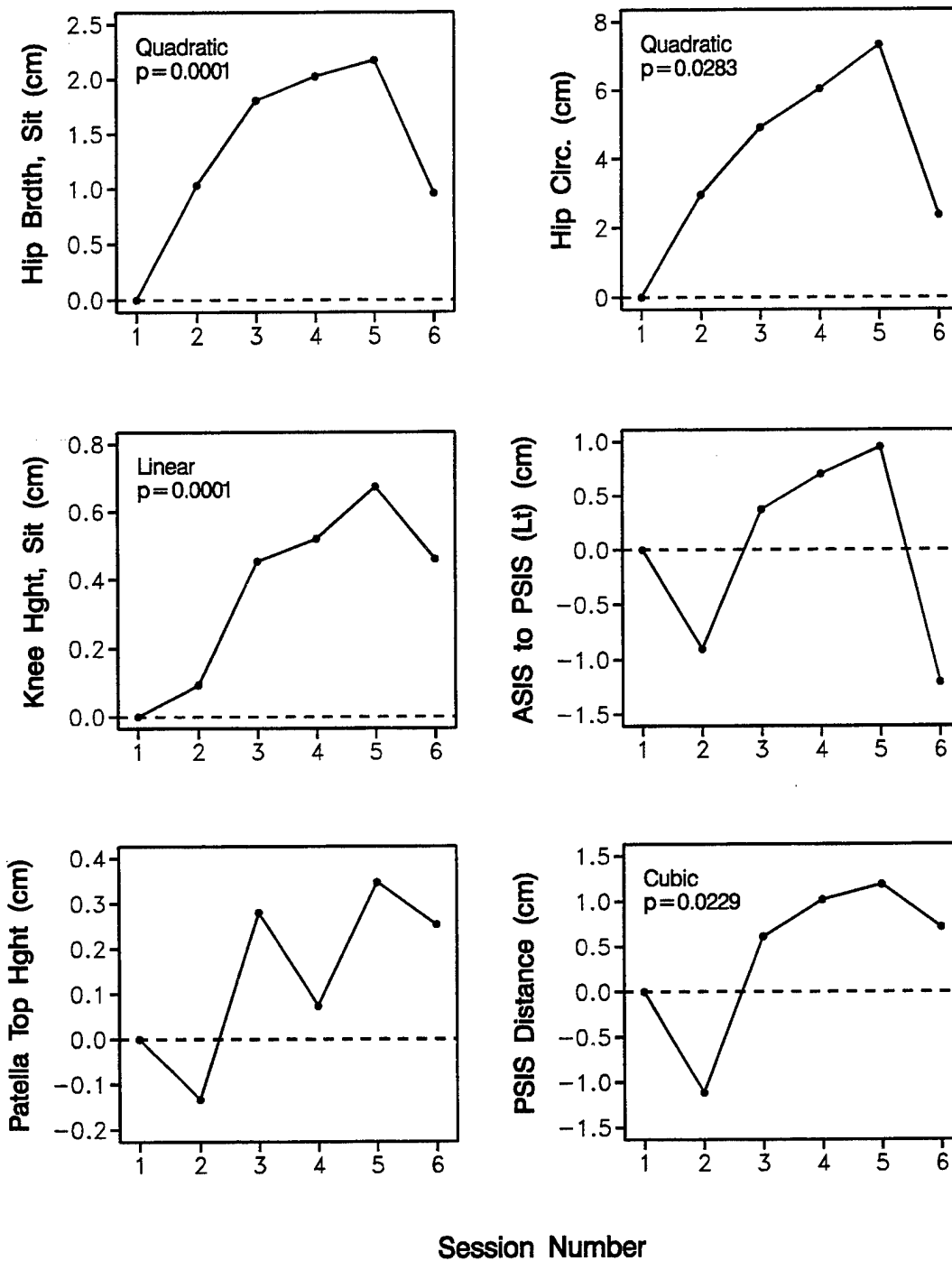


Figure 31. Change from Session 1 Averaged Across Subjects (N=15).

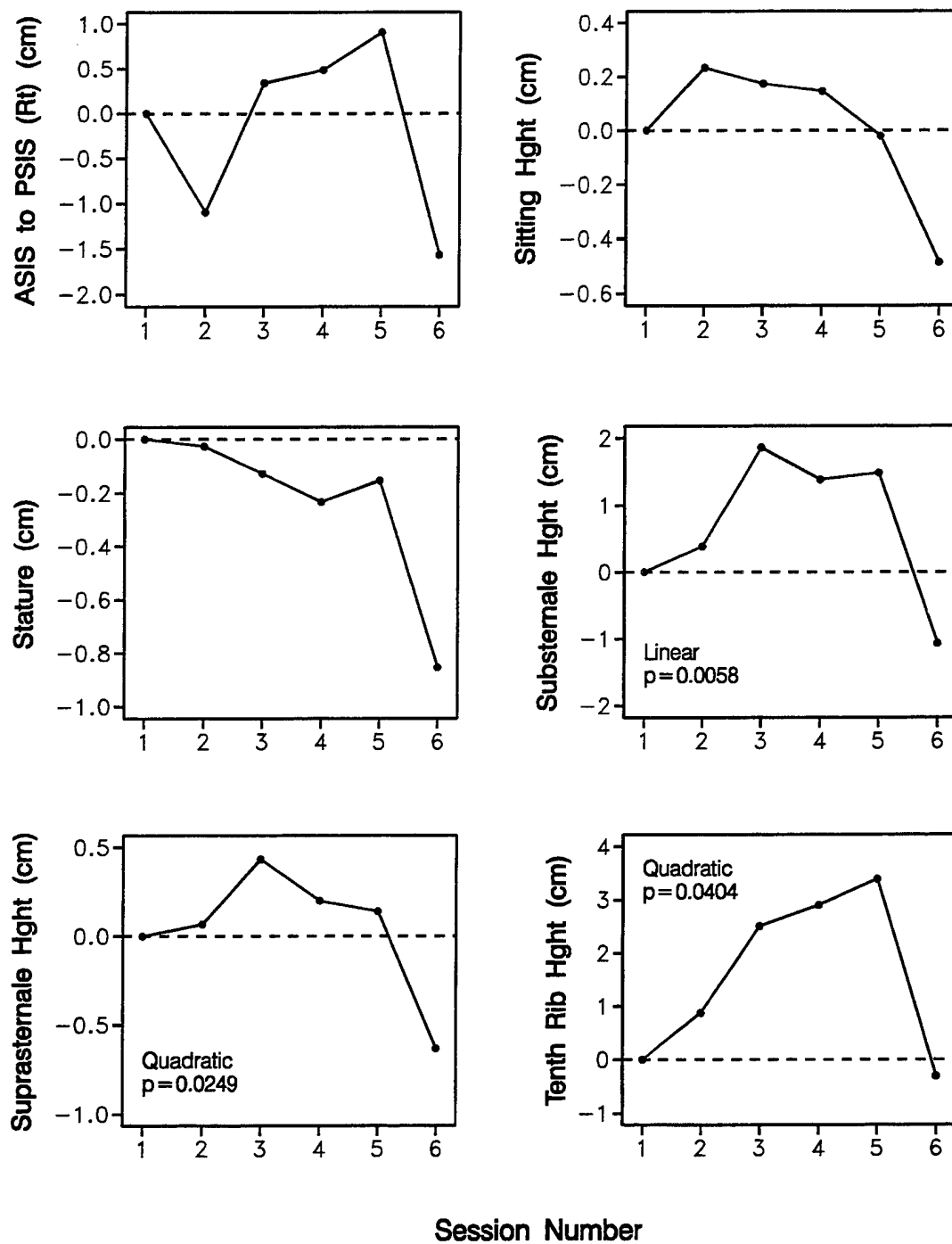


Figure 32. Change from Session 1 Averaged Across Subjects (N=15).

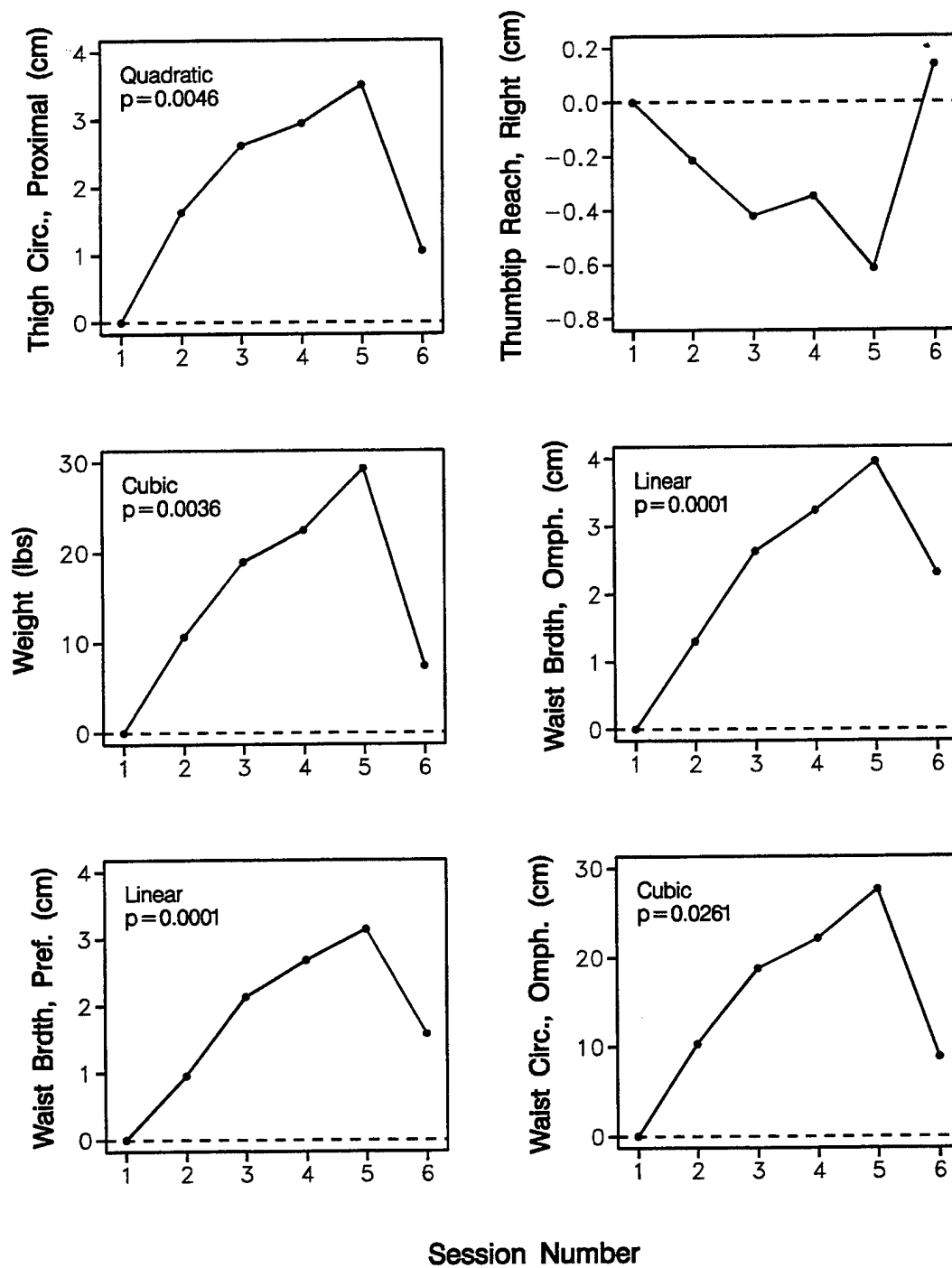
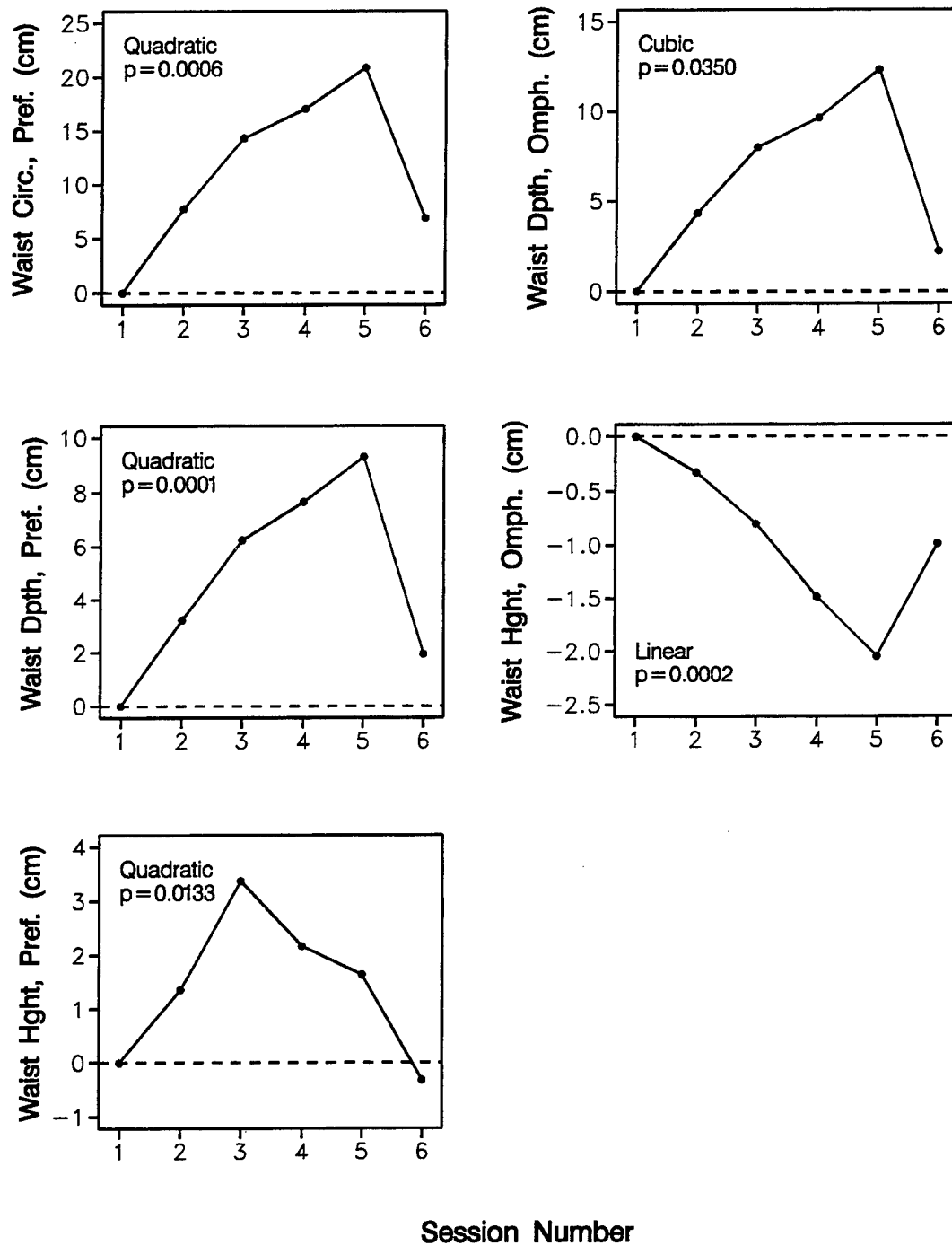


Figure 33. Change from Session 1 Averaged Across Subjects (N=15).

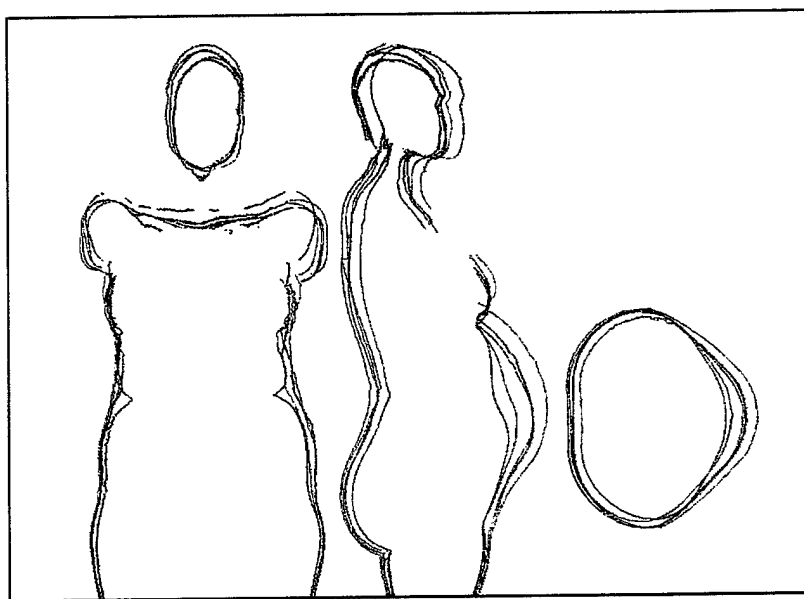


**Figure 34. Change from Session 1 Averaged Across Subjects (N=15).**

### Traditional Measurements as a Percentage Change

The changes pregnant women experience in many traditional measurements were investigated as percentage changes. In fact, the percentage change from one session to the next was calculated by taking the measurement from one session and subtracting the measurement during the previous session, then dividing that quantity by the previous session's measurement.

The percentage change from the first session (earliest stage of pregnancy) to the fifth session (latest stage of pregnancy) was determined for the 15 pregnant women who completed all six data collection sessions. The most obvious changes are in abdominal protrusion, waist circumference, and weight. Figure 35 illustrates some of these changes.



**Figure 35. Changes in Body Dimensions with Pregnancy.<sup>1</sup>**

Waist Depth at Omphalion increased by 63%; Abdominal Extension Depth increased by 53%; Waist Circumference at Omphalion increased by 35%; Weight increased by 21%; Waist Breadth at Omphalion increased by 14%; Chest Circumference increased by 10%; Chest Depth increased by 8%; Chest Breadth increased by 6%; Hip

---

<sup>1</sup> Left: front view of scans 1, 2, 3, 4, and 5 superimposed, Middle: side view of scans 1, 2, 3, 4, and 5 superimposed, Right: cross-sectional view of scans 1, 2, 3, 4, and 5 superimposed.

Circumference increased by 7%; Hip Breadth, Sitting increased by 6%; and Hip Breadth increased by 4%. The percentages above were determined from dimensions measured eight weeks (on average) after the onset of pregnancy, and again at 37 weeks (on average). Of these 15 subjects, 13 women were White, one woman was Black, and one woman was Hispanic. The average age of these 15 subjects was 28 years.

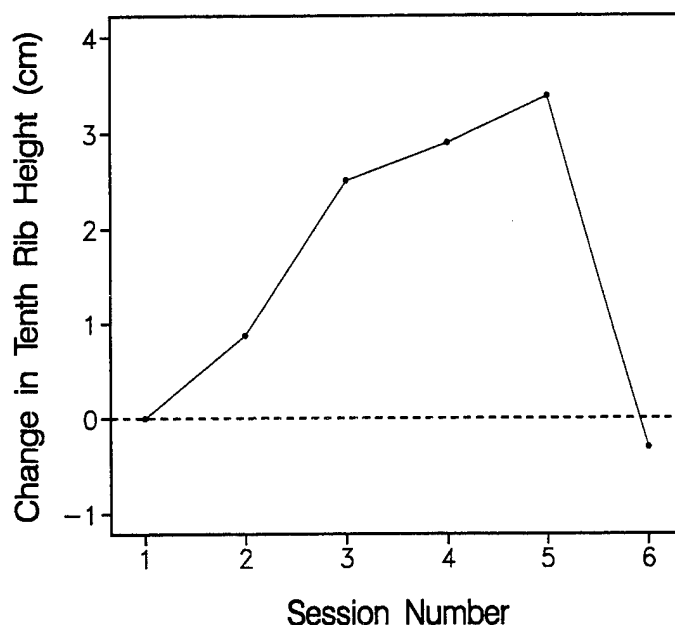
### Tenth Rib Changes

Pregnancy is a time of rapid biological change and all bodily organs and systems are affected by the process (Bullock, J. E., Gwendolen, J. A., and Bullock, M. I., 1987). The uterus starts as a fist-sized organ and grows to occupy most of the pelvic cavity by 16 weeks. As pregnancy continues, the uterus pushes higher and higher into the abdominal cavity, exerting increasing pressure on both abdominal and pelvic organs. As birth nears, the uterus reaches the level of the xiphoid process and occupies the bulk of the abdominal cavity. The crowded abdominal organs press superiorly against the diaphragm which intrudes on the thoracic cavity. As a result, the ribs flare, causing the thorax to widen (Marieb, 1992).

Twelve pairs of ribs form the sides of the thoracic cage. All attach posteriorly to the thoracic vertebrae and then curve downward and forward toward the anterior body surface. The upper seven rib pairs attach directly to the sternum by individual costal cartilages. The remaining five pairs of ribs attach indirectly to the sternum or lack a sternal attachment entirely. In fact, rib pairs 8-10 attach to the sternum indirectly by joining to each other via the costal cartilages immediately above (Marieb, 1992). The Tenth Rib landmark is the lowest point on the inferior border of the tenth (lowest palpable) rib. Rib pairs 11 and 12 are called floating ribs because they have no anterior attachments (Marieb, 1992).

Figure 36 charts the change in Tenth Rib Height (cm) from baseline (Session 1). We would expect there to be an increase in Tenth Rib Height which may be caused by the movement or flaring of the ribs, which could be expanding outward and upward to help accommodate the growing fetus. Figure 36 shows that there was a significant change: on average, Tenth Rib Height increased 3.39 cm from Session 1 to Session 5.

For Tenth Rib Height, no significant change occurred until the 20<sup>th</sup> week of pregnancy (Session 2). The maximum change in Tenth Rib Height (1.64 cm) occurred between the 20<sup>th</sup> and 28<sup>th</sup> week of pregnancy (Session 3). The change in Tenth Rib Height leveled off between the 28<sup>th</sup> and 37<sup>th</sup> week of pregnancy (Session 3 - Session 5), with a change of less than one centimeter.

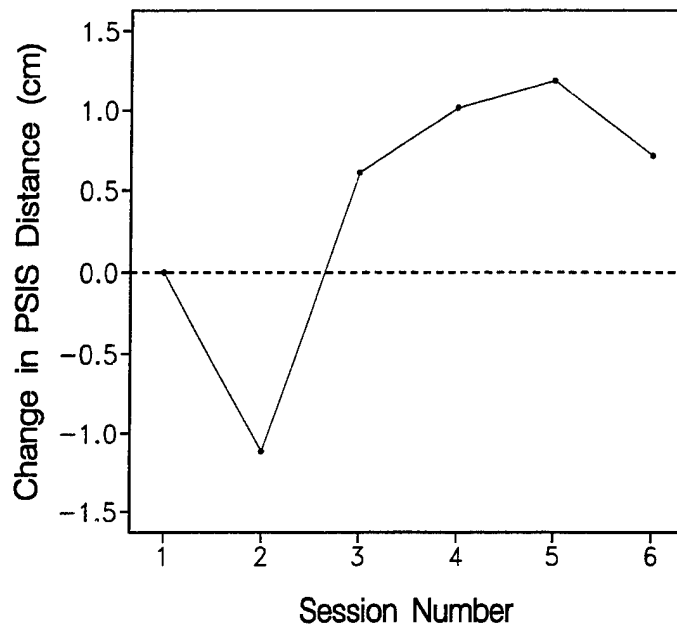


**Figure 36. Change in Tenth Rib Height From Baseline (Session 1).**

#### Posterior Superior Iliac Spine (PSIS) Changes

Relaxin, a hormone mainly generated by the corpus luteum, is present throughout pregnancy. Relaxin causes pelvic ligaments and the pubic symphysis to relax, widen, and become more flexible (Marieb, 1992). Relaxin reaches the highest level in the first trimester. Relaxin remodels collagen, which lowers the strength of connective tissue, permits its expansion and makes it less rigid. Laxity of ligaments has been suggested as a cause of separation and movement of fixed joints in the pelvic girdle (Paul, 1993). For this reason, researchers were interested in the changes in distance between the *Posterior Superior Iliac Spine (PSIS)* landmarks.

Figure 37 charts the change in PSIS distance from baseline (Session 1). The analysis showed that the change in PSIS distance from baseline was insignificant for these 15 subjects. The plot shows the change in PSIS distance from Session 1 to Session 2 actually decreased rather than increasing as we expected.



**Figure 37. Change in PSIS Distance From Baseline (Session 1).**

The change in PSIS distance was calculated using landmarks from the standing scans. There are several factors that may attribute to the insignificant results. (1) There are errors inherent in the measurement of the actual distance between the PSIS landmarks. The location and landmarking of PSIS are not easily done. This difficulty causes small errors in the actual distance measured by the scanner. (2) Because of the physical location of PSIS, the landmark stickers are placed on top of the shorts as opposed to being placed directly on the skin. Thus, as subjects were prepared for scanning, the landmark stickers may have shifted or moved from their initial position.



## Electronic Data Analysis Results

### Radial Difference Mapping

The RDMs for the growth and shape changes from Session 1 to Session 2, Session 1 to Session 3, Session 1 to Session 4, Session 1 to Session 5, and Session 1 to Session 6 for Subject #6 are shown in Figures 38 through 42. The interval distance and corresponding color change is listed at the top of each figure for each RDM.

Figures 38 through 42 include the front, side, and angled views of the RDMs for the changes from scan session to scan session for Subject #6. In each figure, green represents the first scan session (or baseline scan). The remaining colors represent regions of differences for the varying intervals of distances calculated along each radius. The interval values were determined individually for each scan to achieve an informative but not overwhelming number of colors in each RDM.

Note that the values of the intervals vary from figure to figure for each color except green. For instance, orange represents a change in distance between 5 mm and 10 mm for the RDM of Session 1 and Session 2, but orange represents a change in distance between 20 mm and 40 mm for the RDM of Session 1 and Session 3. The interval of distance and the corresponding color associated with each interval are included in table format with each figure.

Figure 38 shows the changes from 12 weeks pregnant to 18 weeks pregnant. The purple area represents the region of most change, which in this case is greater than 15 mm. This region is located higher on the abdomen than expected. The yellow region represents an actual decrease in radial value, which implies a change in posture. Temporary lordosis, or swayback, is the posture change associated with pregnancy and is clearly seen with the negative regions present in the RDMs.

Figure 39 represents the changes from 12 weeks to 30 weeks pregnant. Again, purple represents the region where most change occurred (greater than 60 mm). The shape changes in this RDM resemble a shield. Both the left and right ribs, and the left and right hip bones, can be detected in the RDM, and are contributing factors to the shield shape. This means the location and size of the ribs and hip bones play a part in determining the growth and shape changes during pregnancy. For instance, this woman

may have small hip bones with little distance between them, which prevents growth or shape change in that region. Relaxin, a hormone released during pregnancy, causes the pelvic ligaments and the pubic symphysis to relax, widen, and become more flexible (Marieb, 1992). Laxity of ligaments has been suggested as a cause of separation and movement of fixed joints in the pelvic girdle (Paul, 1993). Therefore, the hip bones widen, but only to a certain extent. The growth and shape changes of the torso, as seen in this RDM, take on the shape of a shield for this subject because the ribs and hip bones act as a barrier or stopping point. Someday we may be able to predict the shape changes undergone during pregnancy based on a women's bone structure.

Another factor may be the number of ribs present. While most people have ten ribs, it is possible to have only nine. A woman with nine ribs may experience shape changes higher in the abdomen than women who have all ten ribs. Torso length and stature are other factors that may contribute to a women's shape changes during pregnancy.

Figure 40 shows the changes from 12 weeks pregnant to 33 weeks pregnant. The purple region represents changes greater than 75 mm. The general shape of the growth region of the woman's torso still resembles a shield.

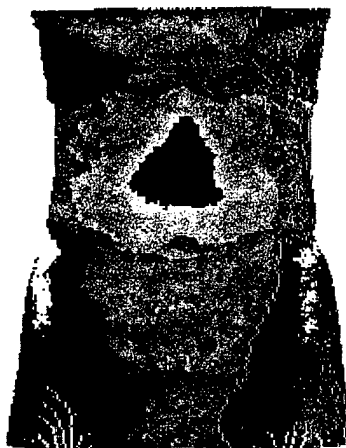
Figure 41 represents the changes from 12 weeks pregnant to 38 weeks pregnant. The purple region represents the most change and is greater than 105 mm. The general shape of the growth still resembles a shield, but the shield seems to have flattened or spread out.

Figure 42 visualizes the shape changes from 12 weeks pregnant to 2.5 weeks after delivery. The yellow region still represents an actual decrease in radial value. However, the yellow present in this RDM is not attributed to posture change. Instead, the yellow covered torso is an indication that Subject #6 was actually smaller at Session 6 (post-delivery scan) than she was at Session 1 (12 weeks pregnant) with the exception of an area across the center of the stomach and on both sides of the torso. In this figure, orange, gray, and purple represent areas where Subject #6 was larger after delivery than she was at 12 weeks pregnant.

This type of information is important because we can now begin to quantify and visualize how a woman changes shape during pregnancy. After delivery, this particular subject's shape returned to her shape at the first session with the exception of an area across the center of the stomach and on both sides of the torso. Information regarding the growth and shape changes during pregnancy becomes extremely important if the woman works in a confined space or tight quarters, and may even determine whether the woman will be able to perform all of her job duties. After delivery, many women will return to their original size and shape, while others may remain larger. Some women become smaller after delivery than they were before pregnancy. With growth and shape information, supervisors will begin to understand how long it will take, and if women will return to their original shape. This will help evaluate whether the woman will be able to resume her original job assignments.

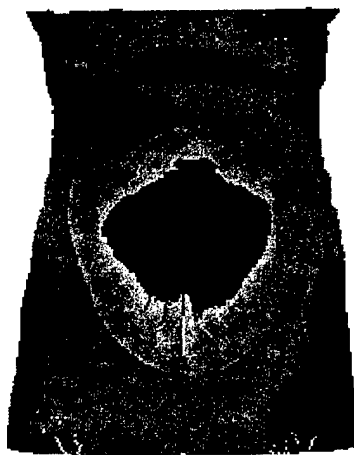
Another interesting finding is that the growth of the torso is nearly universal. Notice that in Figures 38, 39, 40, and 41, the color green, which represents the baseline scan, is not present on the front of the abdomen at all. This means that the whole torso region has shifted or grown at least 5 mm from Session 1 to Session 2, at least 20 mm from Session 1 to Session 3, at least 25 mm from Session 1 to Session 4, and at least 35 mm from Session 1 to Session 5. So, if an article of maternity clothing is being considered for design, the top would need to be larger to accommodate the entire torso, not just the section around the stomach or lower-torso region.

DISTANCE	COLOR
Baseline	Yellow
< 5 mm	Green
5 - 10 mm	Orange
10 - 15 mm	Gray
> 15 mm	Purple



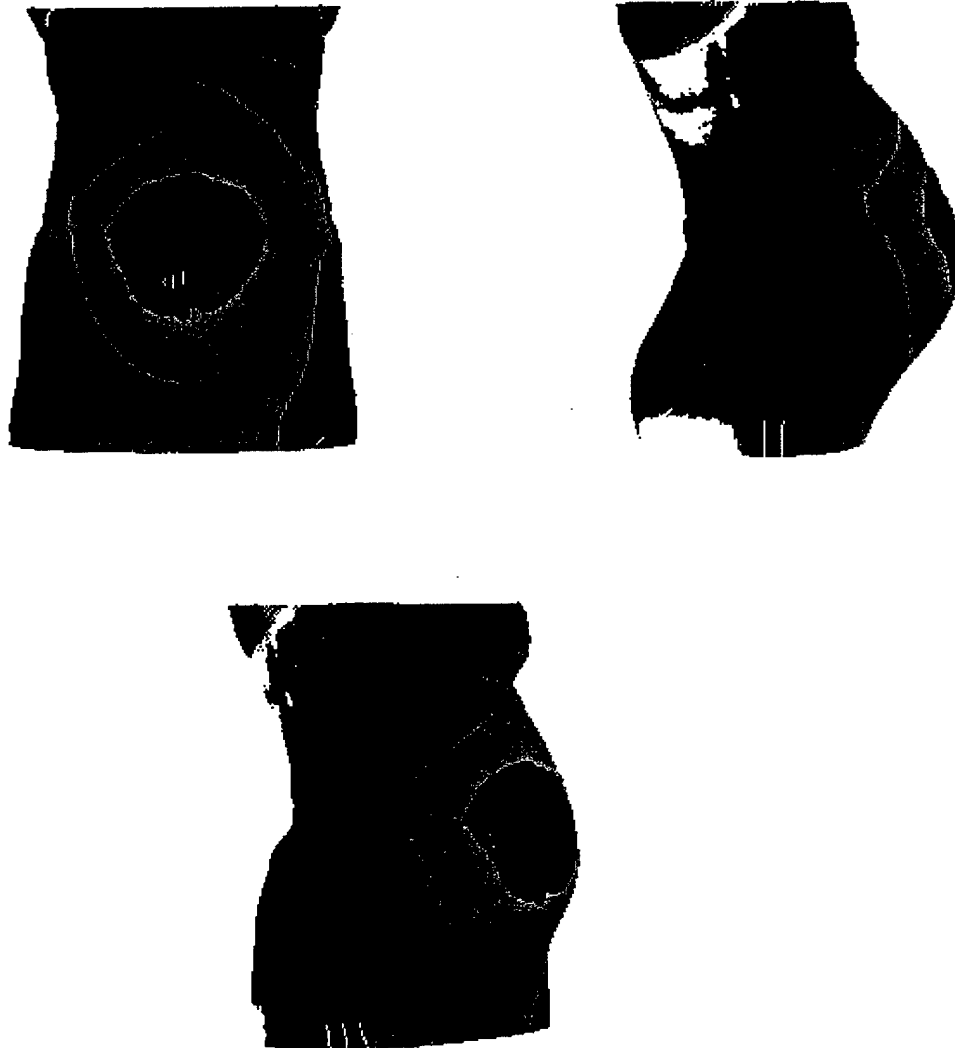
**Figure 38. RDM for Session 1 and Session 2.**

DISTANCE	COLOR
Baseline	Yellow
< 20 mm	Green
20 - 40 mm	Orange
40 - 60 mm	Gray
> 60 mm	Purple



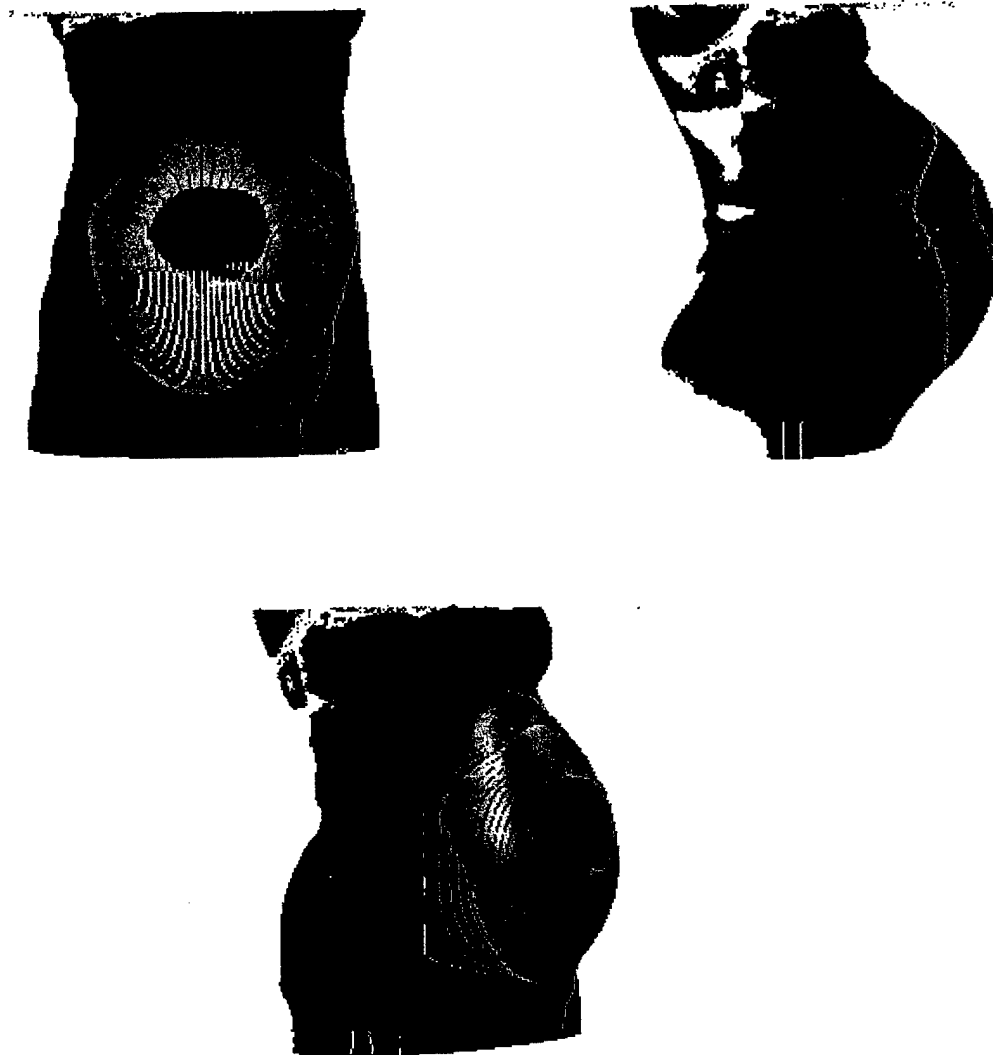
**Figure 39. RDM for Session 1 and Session 3.**

DISTANCE	COLOR
Baseline	Yellow
< 25 mm	Green
25 - 50 mm	Orange
50 - 75 mm	Gray
> 75 mm	Purple



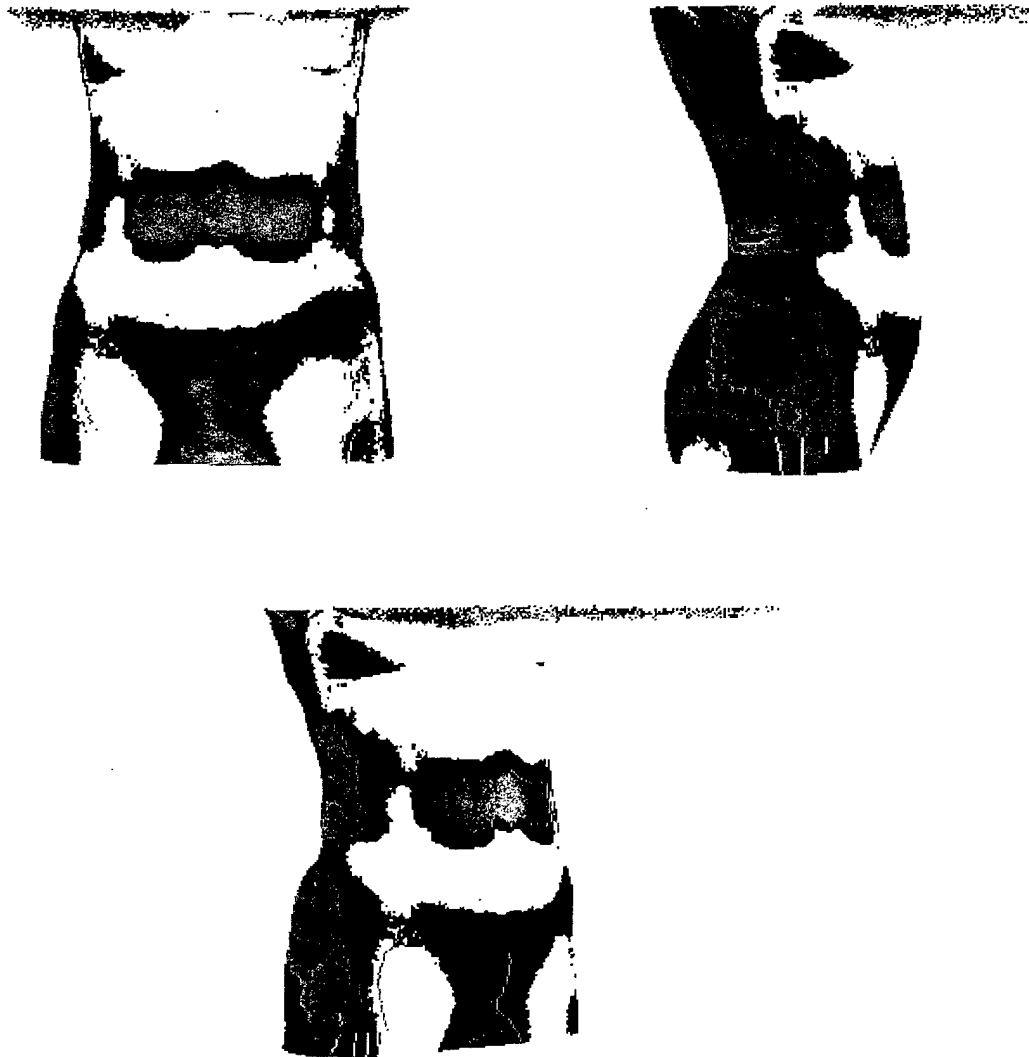
**Figure 40. RDM for Session 1 and Session 4.**

DISTANCE	COLOR
Baseline	Yellow
< 35 mm	Green
35 - 70 mm	Orange
70 - 105 mm	Gray
> 105 mm	Purple



**Figure 41. RDM for Session 1 and Session 5.**

DISTANCE	COLOR
Baseline	Yellow
< 5 mm	Green
5 - 10 mm	Orange
10 - 15 mm	Gray
> 15 mm	Purple



**Figure 42. RDM for Session 1 and Session 6.**



### Euclidean Distance Matrix Analysis (EDMA)

In morphometrics or the measurement of external size and shape, distinctions must be made between size and shape and form. If two objects have the same *shape*, one is a scaled version of the other. If two objects have the same *form*, then both objects are the same *size* and shape.

The use of EDMA to investigate the morphometrics of pregnant women necessitates a distinction between *statistical significance* and *biological importance*. If when testing a statistical (or null) hypothesis (such as,  $H_0$ : There is no difference between two objects) results are statistically significant, then the value obtained from the sample is so extreme as to be an improbable value when the null hypothesis is true.

Since we are not testing hypotheses using EDMA, we do not say our results are “statistically significant.” However, landmarks that are involved in ratios that are substantially smaller or larger than one are instrumental in determining form differences between sessions. One can simply look at the FDM ordered according to the value of the ratios. If those landmarks involved in the extremes, either low or high, combine to form a biologically relevant part of the woman, that part is considered “*influential*” according to Lele and Richtsmeier (1992). Paired landmarks are always considered together due to biological relevance.

Distances between the spine landmarks that are located by measuring from a cervicale reference point did not change over the course of the pregnancy. Those unchanged distances are between cervicale and these landmarks: cervicale -10, cervicale -20, cervicale -30, and cervicale -40.

Tables L-1 through L-15 in Appendix L contain the influential differences for each session comparison based on the critical values in Table 18 on page 53. If a distance between a midsagittal landmark and a landmark that occurs on both the left and right was influential, then the distance to the other paired landmark was also included in the table even if it was not influential on its own. For example, the distance from Waist Omphalion to ASIS left was influential (ratio = 1.37) for the changes between Session 1 and 4. Waist Omphalion to ASIS right (ratio = 1.29) was included in the table even though it wasn't influential itself.

The majority of the influential changes were caused by the increase in abdominal volume over the course of the pregnancy. Distances from landmarks on the back to landmarks around the waist show the increased depth of the abdominal cavity during pregnancy. Also, the preferred waist level became increasingly higher during the pregnancies, while the waist level at omphalion dropped. (Typically as the baby grew and the mother's abdomen swelled, the mother chose to wear the waistband of her clothes somewhere above the largest part of the abdomen.) Since abdominal size and shape changes would seem obvious, readers are left to review those ratios on their own.

A few changes, however, which would not be obvious to many people include the spreading of the ribs, widening of the hips, and increase of chest depth.

The bones in the pelvic girdle spread apart to provide room for the baby during the course of the pregnancy. These changes are tracked by the distances from the left to right PSIS landmarks and from the left to right ASIS landmarks. From Session 1 to Session 2, the average distance between the PSIS landmarks decreased by 4%. (Analysts believe that change was not a true physical change, but was due to the learning curve of landmarking as well as PSIS being difficult to palpate.)

From the second session, the PSIS distances increased over the rest of the pregnancy: 16% from Session 2 to Session 3; 6% from Session 3 to Session 4; and 2% from Session 4 to Session 5. From Session 5 to Session 6, the distance decreased 4%. Only the change from Session 2 to Session 3 was influential for our chosen critical values (see Table 18).

The distances between ASIS left and right landmarks increased continuously from the first through the fifth sessions. The average increase was: 7% from Session 1 to Session 2; 7% from Session 2 to Session 3; 3% from Session 3 to Session 4; and 4% from Session 4 to Session 5. There was a rapid return of the ASIS landmarks towards their original locations evidenced by a 6% decrease in the distance from Session 5 to Session 6. In fact, on average, the ASIS distance at Session 6 was only 1% larger than at Session 1.

The spreading of the ribs was tracked by the Tenth Rib Left and Tenth Rib Right landmarks. Although only one change between sessions was influential using the chosen

critical values, the changes are interesting and biologically relevant. The distance between these landmarks increased: 10% from Session 1 to Session 2; another 5% from Session 2 to Session 3; and 2% more from Session 3 to Session 4. From Session 4 to Session 5, the distance between 10th rib landmarks typically did not change. However, once the baby was born, the ribs quickly began to return to their original locations. By the sixth session, the distance was slightly (2%) smaller than it was at the second session.

Additionally, the distances from the Tenth Rib landmark and ASIS landmark on the same side of the midsagittal plane (from Tenth Rib Left to Left ASIS landmark, and from the Tenth Rib Right to Right ASIS landmark) decreased an average of 22% between Sessions 5 and 6. Also the distances from the Tenth Rib landmark and PSIS landmark on the same side of the midsagittal plane (from Tenth Rib Left to Left PSIS landmark, and from the Tenth Rib Right to Right PSIS landmark) decreased an average of 16% between Sessions 5 and 6. Not only did the lateral separation of the ribs decrease, but the flaring that had forced the ribs upward was reversed.

Changes in distances involving the two bustpoint landmarks can be attributed to the breasts preparing for lactation during pregnancy, and the actual production of milk after delivery. Colostrum, a premilk fluid, is produced toward the end of pregnancy and for the first two or three days after birth. True milk is produced around the third day after delivery (Marieb, 1992). The distance between the Left and Right Bustpoint landmarks increased: by 3% from Session 1 to Session 2; by 5% from Session 2 to Session 3; by 1% from Session 3 to Session 4; by 1% from Session 4 to Session 5; and by 6% from Session 5 to Session 6. Overall the change in that distance from Session 1 to Session 6 was an increase of 12%.

Gravitational forces also caused the Bustpoint landmarks to move downward over the course of the pregnancy as the breasts got larger. The distance from Suprasternale to the Bustpoint landmarks increased an average of 10% from Session 1 to Session 6.

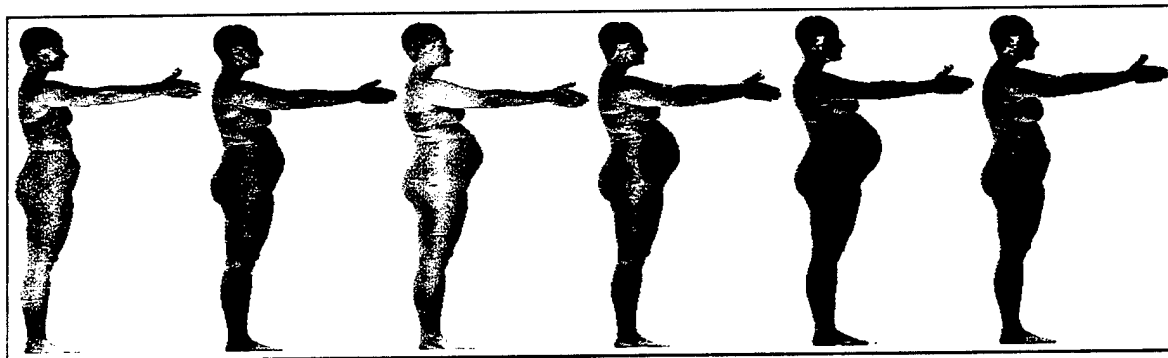
Although it is important to identify where influential and biologically relevant changes took place, it is just as important to know when no influential changes were present. From Session 1 to Session 6, only four distances had changed sufficiently to be considered influential. The vast majority of the measurements were not influentially

different between these two sessions. In other words, by the sixth session, each subject's size and shape had almost completely returned to what they had been at the first session.

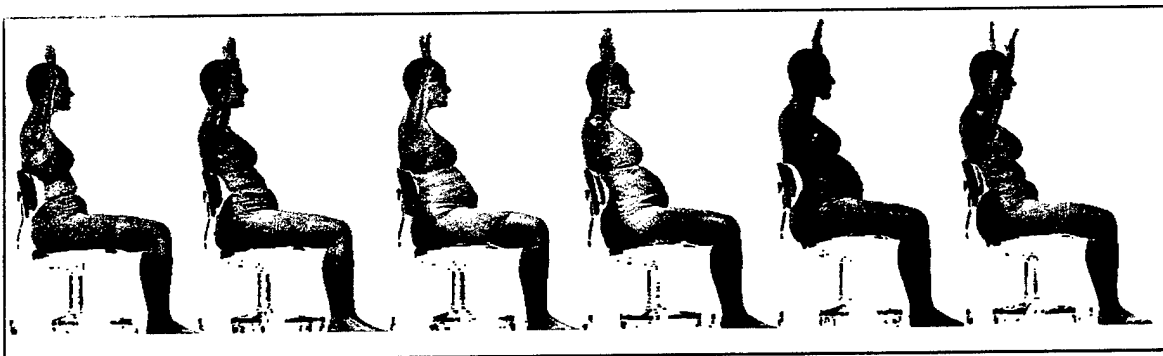
#### Shape Changes During Pregnancy

As the subjects were followed throughout pregnancy, it became evident that women struggle to adjust to the extra size and weight of the developing fetus. Each stage of pregnancy presents a new size and shape change, so it is very difficult for women to adjust to their constantly changing bodies.

A pregnant woman's body assumes an entirely different shape in the standing position than in the seated position. Figures 43 and 44, two series of scans for the same subject in both the standing and sitting posture, show the differences in shape and form.



**Figure 43. Series of Scans for the Same Subject in the Standing Posture.**



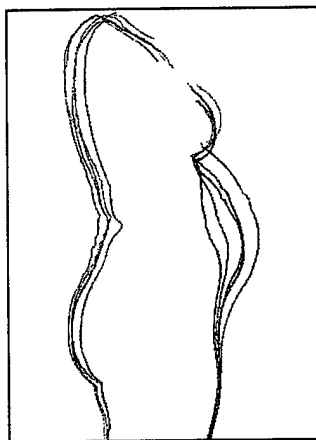
**Figure 44. Series of Scans for the Same Subject in the Seated Posture.**

For Figures 43 and 44, from left-to-right: first scan - 8 weeks, second scan - 21 weeks, third scan - 28 weeks, fourth scan - 31 weeks, fifth scan - 37 weeks, and the sixth scan was completed five weeks after delivery. Scan 1 is less colorful than scans 2, 3, 4, 5,

and 6. During the time between scan 1 and scan 2 technicians installed color filters on the Cyberware WB4 whole-body scanner *Charge Coupled Device (CCD)* camera, which resulted in a more vivid scan.

### Postural Changes

During pregnancy, the magnitude and distribution of loads acting on the spine change dramatically. The increasing bulkiness of the anterior abdomen changes the woman's center of gravity, and many women develop lordosis during the last few months of pregnancy. Lordosis, or swayback, is an accentuated lumbar curvature. Temporary lordosis is common in pregnant women who automatically accentuate their lumbar curvature in an attempt to preserve their center of gravity. In order to maintain equilibrium about the vertebral and hip joints, the weight of the upper body is shifted backwards. The abdominal muscles are also stretched dramatically during pregnancy which may result in a decrease or loss of function which leads to anterior pelvic rotation. Based on postural theory, this rotation also accentuates the lumbar lordosis (Moore, Dumas, and Reid, 1990). This posture change associated with pregnancy is clearly seen in Figure 45, which shows five superimposed, 3-D whole-body scans of one subject throughout pregnancy.



**Figure 45. Scans 1, 2, 3, 4, and 5 Superimposed.<sup>2</sup>**

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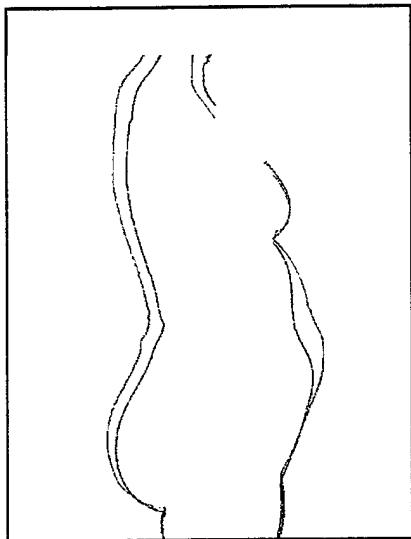
<sup>2</sup> Scan 1 (red, 8 weeks), Scan 2 (purple, 21 weeks), Scan 3 (green, 28 weeks), Scan 4 (blue, 31 weeks), and Scan 5 (gray, 37 weeks) superimposed for Subject #8.

Additionally, Figure 45 shows that the trunk angle is increased for this particular subject. This increased trunk angle, together with the increased weight of the pregnant abdomen, increases the torque on the lumbosacral junction, requiring an increase in the developed muscle tension (Nicholls and Grieve, 1992). This change in posture may be associated with low-back pain during pregnancy, experienced by an estimated 49% of women at some point during their pregnancy (Moore, Dumas, and Reid, 1990).

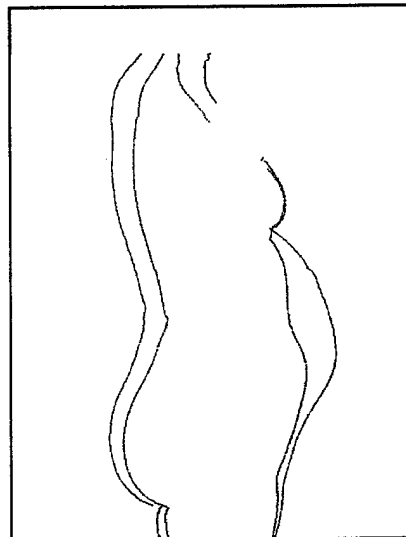
When the first scan of this subject was superimposed with the second, third, fourth, and fifth scans individually in Figures 46 through 49, a marked increase in the angle of trunk inclination is clear. As the pregnancy progressed from eight weeks to 37 weeks, posture changed dramatically. Figure 50 shows the change of declination of the spine for a subject five weeks after delivery compared to 37 weeks pregnant.

Many studies have addressed the postural changes associated with pregnancy and their relationship with low-back pain. The stated changes in lumbar curvature associated with pregnancy differ considerably between authors. The intent of this section is not to draw conclusions concerning lumbar curvature during pregnancy, but to simply demonstrate that the 3-D data can be used to determine the postural changes for each individual subject.

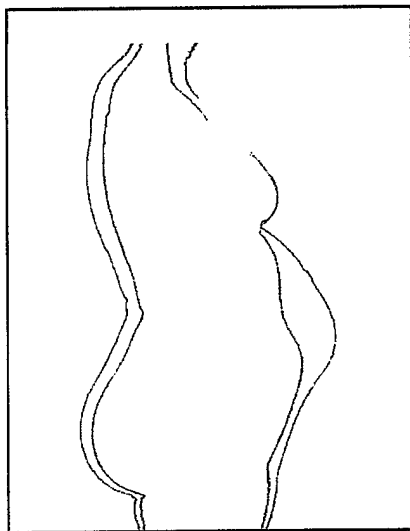
The various combinations of scans in Figure 46 through Figure 50 were superimposed using the registration process feature in INTEGRATE (see Appendix J for a description of the INTEGRATE software). The landmarks used in the registration process appear in Table 19. Researchers chose these landmarks because they felt finding the location of the landmarks was less difficult, therefore more consistent. Also, the landmarks listed in Table 19 were less likely to change over the course of pregnancy in comparison to the other landmarks. In addition to the landmarks, researchers also used the leg, particularly the upper thigh region, and visual inspection to align the scans as consistently as possible. This was important to capture the true postural change associated with pregnancy opposed to the changes present in the posture due to the position of the subject from scan session to scan session.



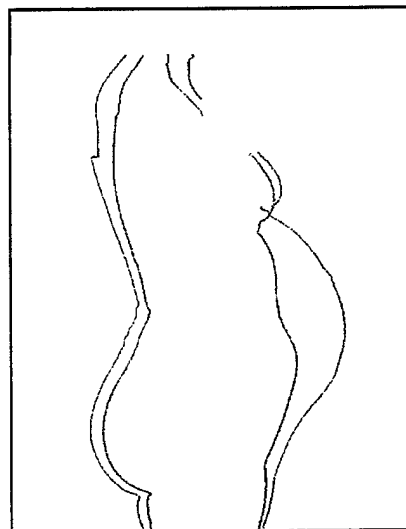
**Figure 46.**



**Figure 47.**



**Figure 48.**



**Figure 49.**

**Figure 46. Scan 1 Superimposed with Scan 2.<sup>3</sup>**

**Figure 47. Scan 1 Superimposed with Scan 3.<sup>4</sup>**

**Figure 48. Scan 1 Superimposed with Scan 4.<sup>5</sup>**

**Figure 49. Scan 1 Superimposed with Scan 5.<sup>6</sup>**

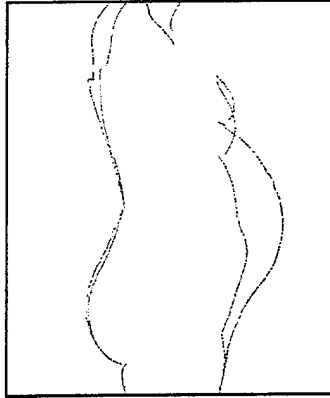
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<sup>3</sup> Figure 46. Scan 1 (red, 8 weeks) superimposed with Scan 2 (purple, 21 weeks) for Subject #8.

<sup>4</sup> Figure 47. Scan 1 (red, 8 weeks) superimposed with Scan 3 (blue, 28 weeks) for Subject #8.

<sup>5</sup> Figure 48. Scan 1 (red, 8 weeks) superimposed with Scan 4 (green, 31 weeks) for Subject #8.

<sup>6</sup> Figure 49. Scan 1 (red, 8 weeks) superimposed with Scan 5 (gray, 37 weeks) for Subject #8.



**Figure 50. Scan 5 Superimposed with Scan 6.<sup>7</sup>**

**Table 19. Landmarks Used in Registration Process.**

Landmark Name
Cervicale
Cervicale -10
PSIS Left
PSIS Right
Suprasternale

Just as pregnant women encounter unique size and shape changes during pregnancy, they also experience varying levels of postural changes or lordosis. These varying levels of postural changes could impact the accommodation of pregnant women in their workplace, and may even decrease productivity.

## PROBLEMS ENCOUNTERED

### Fetal Movement

Movement of the fetus during sessions presented a problem when landmarking, measuring, and scanning. For example, a certain landmark was identified and once the fetus moved or shifted positions, it became difficult to relocate the same landmark again (during the same session). Also, fetus movement during scanning caused shading in some scans (shading will occur when there is a void in the data). Highly shaded areas

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<sup>7</sup> Figure 50. Scan 5 (gray, 37 weeks) superimposed with Scan 6 (purple, 5 weeks after delivery) for Subject #8.



usually involve the area between the legs and under the arms of the scan. The amount of shading due to fetus movement depends on the position of the fetus at the time the laser passes over the abdomen during the scan. For example, one subject felt the baby move as the laser passed the abdominal area. The subject commented that she could actually feel the baby's arm in this area, but was unable to move it so the scan could be repeated.

#### Landmark Location

Several landmarks became hard to find as the subjects progressed through pregnancy. Tenth Rib is one landmark which became noticeably difficult to landmark on some subjects once the abdomen started protruding significantly. The Tenth Rib landmark is the lowest point on the inferior border of the tenth (lowest palpable and last attached) rib. Sometimes, the ninth rib was located first and used as a guideline to find the Tenth Rib. It was much easier to find the Tenth Rib landmark if the subject carried the baby low. A subject who carried the baby high tended to present more of a problem, because palpation of the tenth rib became nearly impossible because the baby was in the way. Sometimes, when a landmark was difficult to find, the subject provided useful insight and assistance.

Another series of landmarks, ASIS, PSIS, and Iliocristale, located on the pelvic girdle, became progressively harder to palpate and locate on pregnant women once the abdomen changes and muscles start to tighten. ASIS (Anterior Superior Iliac Spines) are the uppermost of two pair of prominences on the anterior rims of the ilia. The ilia are one pair of the three pair of bones which comprise the bony pelvis, and the difficulty may be attributed to the physical structure of the pregnant woman. The ASIS is located on the front ridge of the hip bone. During late stages of pregnancy, this landmark may be physically impossible to locate, depending on where the fetus is positioned at the time.

The Humeral and Femoral Epicondyles also become more difficult to palpate as pregnancy progresses. The Femoral Epicondyles are the bony protuberances at the distal end of the right and left femur. The Humeral Epicondyles are the bony protuberances at the distal end of the right and left humerus. These bony points, located around the knee,

have proven problematic with certain subjects. We believe this was due to muscle build-up caused by carrying the extra weight of the baby and the additional weight of the mother. Excess fluid around the knee also made the landmark more difficult to find.

Even though a few landmarks have proven difficult to locate late in the pregnancy, past experience with the subjects helps estimate where these hard-to-find landmarks might be located. Because the subjects were landmarked, measured, and scanned before any obvious body size and shape changes occurred, those changes were considered when locating--and sometimes estimating the location of--landmarks in later sessions.

The additional time it took to locate landmarks on subjects late in their pregnancies was significant because it added to the amount of time the subject spent in the CARD Laboratory for the data collection process. The traditional anthropometric data collection should have taken approximately 60 minutes, and the collection of the 3-D anthropometric data took approximately 15 minutes. However, due to increased difficulty locating several of the landmark locations, the traditional data collection time increased to 90 minutes or longer. Subjects also required more frequent breaks as their pregnancies advanced.

#### Traditional Data Collection Posture--Standing

In the standard posture for traditional data collection, the subject stood erect with the head positioned in the Frankfurt Plane, with the heels of the feet together, and the toes apart. With the exception of one, all subjects were able to stand in this standard anthropometric posture for the traditional measurements. The subject who could not assume the standard posture had experienced a back injury, and felt off-balance with her heels together. To compensate for this change in position, the subject stood erect with her head positioned in the Frankfurt plane with her heels 20 cm apart. A landmark dot was placed on the floor at both sides of her heels to provide foot placement for her next data collection session.

### Lightheadedness or Dizziness

In assuming the traditional standing posture, several subjects experienced problems with instability and loss of balance which did not exist prior to pregnancy. In some cases, the subject required additional breaks during the traditional data collection process due to lightheadedness or dizziness. Standing in the standard posture for an extended period of time sometimes caused a subject to feel faint. Subjects sometimes locked their knees while standing in this position, which resulted in dizziness or lightheadedness due to blood flow restriction.

### Traditional Data Collection Posture--Sitting

A few subjects experienced difficulty putting their knees together for the seated hip breadth measurement. This was usually a problem only if the position of the abdomen prevented the subject from assuming the required measurement position. When this problem occurred, the subject was helped when the technician pushed on the lateral sides of both legs very gently. Some subjects also had trouble sitting up straight during the sitting height measurement. This happened when a subject experienced lower back pain when sitting very straight, or when a subject could not remain seated in an erect position for a long period of time. When this happened, the subject was asked to sit up as straight as possible for as long as she could while the measurements were taken.

## LESSONS LEARNED

### Environmental Control

During pregnancy, many physiological and metabolic changes occur in the body. The blood volume increases by 25% to 40% by the thirty-second week, consequently the blood pressure and pulse typically rise and increase cardiac output by 20% to 40% at various stages of pregnancy (Marieb, 1992). The placenta also releases a hormone which increases the rate of maternal metabolism throughout pregnancy, causing hypermetabolism (Marieb 1992). Because of these physiological changes and increasing hormone levels, pregnant women tend to have a higher body temperature than non-pregnant women. These factors, coupled with an unusually warm data collection area,

may have contributed to those incidences where dizziness and lightheadedness occurred. One of the important lessons learned during this study was the need to control and regulate the temperature of the data collection area. The room temperature needed to be 70° F or colder, with proper air circulation and ventilation. Because we experienced difficulty maintaining the desired temperature for data collection, a floor fan was used to help control the situation.

#### Dedicated Data Collection Tool

This study represents a collaborative effort between the U.S. Army, the U.S. AFRL, the U.S. Air Force Regional Medical Center, and Sytronics, Inc. The WB4 whole-body scanner is a resource of the U.S. AFRL, which was gearing up for a large-scale, multi-million dollar survey of its own at the time data collection for this effort was beginning. While the whole-body scanner as a shared resource made this particular phase of data collection possible, we recommend that future efforts provide for a dedicated data collection tool. It is precisely because the whole-body scanner was a shared resource that some of the data collection sessions for PWS subjects were shifted slightly. Future efforts may not allow for such shifts in schedule, and may suffer as a result.

A far greater threat to data collection for this phase was changes, software and hardware upgrades, and technology advances affected the status of the scanner. Each time the data collection tool is changed, the potential impact of the changes on the collected data is not predictable. There are two possible repair or upgrade delays that may result.

#### Repair or Upgrade Down-time Delays

Each time the scanner was repaired, examined, or upgraded, there was operational down-time in the process. Critical data collection sessions for PWS had to be postponed as a result. Each time the scanner was changed in any way, it was a very real possibility that there would be problems encountered which could potentially require large amounts of time to solve. If such a problem was encountered, the scanner could be unavailable for an extended period of time. Our experience was that the problems encountered

caused delays of up to several days, which did result in delayed or missed data collection sessions for PWS. We were, however, extremely fortunate. Future researchers who choose to share a resource like the scanner may not be as fortunate.

Because the large-scale, multi-million dollar survey was the Air Force priority for the whole-body scanner, it was impossible to delay changes until data collection for the PWS effort was completed. We believe it is critical that future efforts include a data collection tool that is a dedicated resource. If the cost of obtaining and maintaining a dedicated resource is prohibitive (the cost are extremely high), we recommend, at the very least, a contractual agreement that the scanner will be available at the prescribed times, and that no changes, advances, or upgrades be performed until data collection for the effort has concluded.

#### Frequency of data collection sessions

For this study, the number of data collection sessions was determined based on the existing budget. The small number of active-duty subjects required that the sample be augmented with civilian women who met the U.S. Air Force and U.S. Navy military height/weight entrance requirements before they became pregnant. Due to existing regulations, active-duty military women could not be paid for time or mileage; however, non-military subjects were paid \$8.00 per hour and \$.30 per mile (traveled to and from the data collection site). Because the original goal was to collect data on military personnel only, the added cost of paying non-military subjects to participate in the study was an unanticipated expense. This unanticipated expense, subtracted from the existing budget, left enough money, based on projected costs, for a total of six data collection sessions per subject.

Therefore, the six sessions had to be spread out over 40 weeks of pregnancy in a way that would capture as much size and shape change as possible. Because most abdominal change occurs during the third trimester, we scheduled three of the six data collections sessions during that time.

Unfortunately, our data suggest that scheduling the second session at 20 weeks and the third session between 28 and 29 weeks resulted in a larger change in body size and

shape between these two data collection sessions than anticipated or desired. Because the purpose of this study was to track the body size and shape changes undergone during pregnancy, smaller intervals of time between data collection sessions are recommended.

The schedule in Table 20 is recommended for future data collection focusing on the size and shape changes undergone by pregnant women. On average, subjects completed the sixth session at three and one-half weeks after delivery. Another suggestion is to have three post-delivery sessions: one scheduled two weeks after delivery, another scheduled one month after delivery, and a third scheduled two months after delivery.

**Table 20. Recommended Data Collection Schedule.**

Session	Number of weeks pregnant
1	Baseline Session - completed prior to noticeable weight and/or body changes
2	12 weeks
3	16 weeks
4	20 weeks
5	24 weeks
6	28 weeks
7	32 weeks
8	34 weeks
9	36 weeks
10	38 weeks
11	Post-delivery - completed two weeks after delivery
12	Post-delivery - completed one month after delivery
13	Post-delivery - completed two months after delivery

#### Questionnaire responses

The questionnaire responses were designed to be completed by subjects as close to the 20<sup>th</sup> week of pregnancy as possible. Because subjects were at different stages of pregnancy (number of weeks pregnant varied from one subject to another) at onset of

data collection, it was nearly impossible to get the questionnaire responses from each of the subjects at precisely the 20<sup>th</sup> week of pregnancy. Questionnaires were given to the subjects at their first session and they were instructed to bring the completed questionnaire with them to their next session. However, many subjects forgot to return with the completed questionnaire's on the second session as instructed. This resulted in questionnaire responses at a variety of numbers of weeks pregnant. To avoid this situation in future research, we will have the subjects complete the questionnaire during their second session, which will be scheduled at the 20<sup>th</sup> week for each subject. In most cases, subjects volunteer to take the questionnaires home to complete at their own leisurely pace in order to give more detailed answers.

#### Incentives for Military Subjects

Subject recruitment proved to be the most challenging part of this study. The goal was to collect data on 25 pregnant, active-duty military women. These 25 subjects were to represent the tri-service military population. Both military and non-military subjects received a color print out of each scan for participating in the study. Non-military subjects were also paid \$8.00 an hour and \$.30 per mile for travel reimbursement to and from the CARD Laboratory. In adherence to the Air Force Regulation Standard of Conduct rules, military members were not paid or reimbursed for their travel to and from the data collection site. Because the attrition rate for active-duty military subjects is high, an incentive seems necessary for the recruitment and retention of military subjects. Suggested incentives include: money, a gift certificate, a car seat, or coupons for free diapers or baby items. These incentives may help increase the participation of military subjects.

#### Methodology

##### Landmarks

##### Size and Color:

The landmark dots (or stickers) used for the PWS were round, blue, 9 mm, Avery-brand dots. During the course of the study, researchers in the CARD Laboratory discovered that round, white, ½ inch, Avery-brand dots were better illuminated and easier to identify in the scans. This was discovered in the process of adjusting the

luminance option (black and white) for automatic landmark detection for the *Civilian American and European Surface Anthropometry Resource (CAESAR)* project. The PWS strictly used the color option throughout the entire study. Even though researchers discovered white dots were easier to identify in both color and luminance scans, blue stickers were used for the remainder of the PWS, for consistency.

#### Placement:

When placing the landmarks on the spine, subjects were seated on the table used for traditional anthropometric data collection. Subjects were told to sit erect, look straight ahead with their arms relaxed at their sides. The Cervicale landmark was located first. Then, a tape measure was used to mark Cervicale -10, Cervicale -20, Cervicale -30, and Cervicale -40. One technician held the tape measure as straight as possible, while the other technician placed a mark with an eyeliner pencil on the spine at 10 cm intervals. One noticeable problem is that the standing posture for scanning is not similar to the posture subjects assumed during the spine landmarking procedure. This may lead to small errors when using the landmarks from the scans for analysis and design. How much error exists is unknown. For future work, it is recommended that these spine landmarks be placed on the subject when the subject is in the same posture that will be used for scanning.

#### Checklist

One last recommendation regarding the landmark portion of the study is to count out the number of landmarks needed prior to landmarking. This helps technicians account for every landmark and ensure all are present for data collection. A landmark checklist is also recommended for the scanner station, so researchers can make one final check before scanning. Also, the checklist should be used between scans, if there is more than one scan.

#### Head Covering

Latex caps were used to cover the subject's hair during scanning. The caps were made from certain size head forms from a previous study in the CARD Laboratory. The latex caps conform poorly to the head. They do, however, hide most of the subject's hair



during scanning, which would otherwise cause missing data. Nylon caps are used for CAESAR instead of the latex caps. The nylon caps are inexpensive, and completely cover the hair. At the same time, these nylon caps conform better and allow the scanner to capture a more accurate shape of the subjects' head. Like the latex caps used for the PWS, the nylon caps used for CAESAR data collection are nude in color.

### Clothing

Standard bike shorts (maternity and non-maternity) and sports bras were used for data collection for the PWS. Several adjustments were made to the clothing for CAESAR, as a result of PWS. The tops were re-designed by Jantzen. Standard sports bras do not allow the scanner to capture information on the sternum and surrounding areas. The revised top resembles a woman's bra, but still completely covers nearly all bra types. However, for PWS, subjects were instructed not to wear their own bras underneath the sports bras in an effort to capture as much size and shape information possible given the garments we had. The newly designed Jantzen sports bras were more form fitting and provided more shape information. The maternity bike shorts worked well because there was an elastic band in the waist, which allowed adjustment if required. The non-maternity bike shorts did not have an adjustable elastic waist so they tended to indent the waist to a certain extent depending on the shape of the subject. Once again, the shorts designed especially for CAESAR, were specially sized and shaped so that they would not indent the waist and would follow the contours of the body. The bike shorts and sports bras used for PWS were sufficient, and the need for the design and production of the special garments was not anticipated, and therefore, no funds were initially allocated for garment design or manufacture. We strongly recommend that future research involving the measurement or scanning of pregnant women allocate resources for these and other issues which may arise but which may not be anticipated due to the newness of this technology and the limited availability of information on pregnant women as a population.

## CONCLUSIONS

The rapid rise in the female population among service personnel has created a proportional rise in pregnant female service members. This creates an additional increase in total manpower demands to meet the displaced pregnant service women. Unit readiness and sustaining day-to-day operations in the unit becomes a problem when several small workcenters are affected by the loss, due to pregnancy, of a trained team member.

The question of the effect of pregnancy on mission-effectiveness is two-fold: (1) medical -- mother/fetus health and safety, and (2) physical -- ergonomic constraints due to changing body size and shape. Focusing on the physical factor of mission-effectiveness and the subjectiveness of its evaluation, it is postulated that changing body size and shape, along with reach constraints during the later stages of pregnancy, could adversely affect occupational performance and safety.

Current military policies remain vague when a pregnant service woman's duties must be curtailed or reassigned. The tri-services have similar policies where the duty is similar. At every activity, some effort is made to assign pregnant women to jobs appropriate for their ratings. For instance, in the Navy, women that become pregnant while on sea duty must be transferred to shore commands by the end of the 20<sup>th</sup> week of pregnancy. Concern has been expressed that these pregnant women cannot be utilized appropriately at the shore commands to which they are transferred because of restrictions on the tasks they perform.

Air Force personnel are affected by AFR 36-20 and AFR 39-11 which view pregnancy as a temporary limitation. A Physical Profile Report (Form 422), is completed by a medical officer, supervising officer, and the pregnant service woman.

Many safety and performance issues within the workplace are addressed with technical understanding of bio-chemical hazards, environmental exposures, physical requirements, and hazardous duty requirements. However, there are no guidelines relating to physical accommodation requirements for duty. Before this study, there was no general 3-D anthropometric data which quantifies shape changes during pregnancy. Thus, the workstation accommodation has not been addressed.

There are many differences in the abdominal anthropometry and physical characteristics between pregnant and non-pregnant women. They are related both to changes in the mother and to pregnancy stages. Until now, there was no significant body of data to provide both traditional and 3-D anthropometry for measuring shape change during pregnancy. Kroemer states that many brochures and books in anatomy, obstetrics, and gynecology contain "normative" tables about changes in body dimensions with pregnancy, but apparently few data have been measured on large population samples in recent years (Kroemer, 1994). In an attempt to compile data for the United Kingdom, Pheasant was able to find only one anthropometric survey of pregnant women, and that was done in Japan. So, he was forced to estimate the anthropometric changes of British women based on Japanese data (Kroemer, 1994).

A 1990 General Motors Study investigated anthropometry of seated pregnant women to define fetal envelopes for crash protection, however this study did not address the mother's overall body size for accommodation. Drawings from the University of Michigan Transportation Research Institute were used to determine the body ellipses because no whole-body scan data on pregnant women existed.

Understanding anthropometric characteristics during pregnancy provides the first step in the evaluation of duty for pregnant women.

The primary purpose of this study was to collect a set of traditional anthropometric data as well as a 3-D whole-body scan data set for a sample population of approximately 25 pregnant women.

This study can serve as a pilot (or preliminary) study, the results of which may be used to guide future research on the size and shape changes that characterize the pregnant human body. There were no previous studies of pregnant women involving the collection of size *and* shape (surface contour) data. For this reason, there was no existing body of knowledge (with respect to 3-D data) from which to draw. Therefore, this study was designed to be a first-step into this arena. Future research can incorporate the lessons learned from this effort, several of which may prove critical to the success (or failure) of future efforts.

Subject recruitment and data collection began in December, 1996. Our goal was to begin the study with 50 females, if possible, in order to obtain an end sample size of approximately 25 females. Due to attrition and other factors, the small number of active-duty subjects were augmented with civilian women who met the U.S. Air Force and U.S. Navy military height/weight entrance requirements before they became pregnant. The subject recruitment efforts were then expanded from Wright-Patterson Regional Medical Center to include local doctors' offices as well. The full-scale effort to recruit subjects ended May 1997 when 35 subjects had enrolled. This recruitment end date was driven by the non-availability of the whole-body scanner after January 1998 due to the requirements of the CAESAR study.

Because subject participation was on a volunteer basis, we could not obtain a sample with the same racial mixture as the tri-service active-duty female population. However, the age distribution of the subjects who completed the baseline session and at least one additional session was a good representation for the range of ages for women in child-bearing years. Even though subject participation was voluntary, the PWS sample represents the range of heights and weights for the active-duty population (Air Force, Army, and Navy).

A list of subjects, including the dates when sessions were completed, appears in Appendix M. Appendix M also shows how many weeks pregnant each subject was when each session was completed. Also included in Appendix M is the target date, or latest possible date for each subject to complete a given session according to pre-determined intervals (one session during the first trimester, one session during the second trimester, three sessions during the third trimester, and one post-delivery session). Researchers used this record when scheduling subjects for each data collection session. Sessions that were missed are highlighted in the table.

The subjects who completed the baseline session and at least one additional session also completed a questionnaire. The questionnaire focused on topics related to the subject's work environment such as whether the pregnant woman has a desk job, non-desk job, or a combination of both. Other topics include typing tasks, frequency and duration of breaks and lunches, lifting objects and reaching for objects while standing,

and lifting and reaching for objects while sitting. A majority of the subjects were employed, and the number of subjects who were employed were split evenly between active-duty military and civilian. The employed subjects were also nearly evenly split between desk and non-desk jobs. Therefore, the information provided on pregnant women covers more than one type of working situation or environment.

Summary statistics describing the anthropometry for the 15 subjects who completed all six data collection session is provided in table format. The mean, standard deviation, minimum, and maximum are given for each measurement taken. The changes in traditional anthropometric measurements from the baseline session for these 15 subjects are also given in table format. These changes in the traditional anthropometric measurements from baseline are also shown as Box and Whisker plots.

While mean changes are indications of overall trends, the variation among individuals can be very informative, particularly for small samples. Plots of each subject's change from Session 1 over the entire period of pregnancy, including post-delivery, show how the different women changed from Session 1 to Session 6. Most of the subjects follow a similar trend, and only a few deviate slightly.

A trend analysis was performed on each traditional measurement using Repeated Measures GLM analysis. The trend analysis was performed to see which dimensions had significant change during the course of pregnancy. Only Session 1 through Session 5 was included in the GLM analysis. This analysis was completed for the 15 subjects who completed all six data collection sessions.

Many of the changes in body dimensions were calculated as percentage changes from one session to the baseline session. For most traditional measurements, there was an increase from Session 1 to Session 5, then a sharp decrease from Session 5 to Session 6, as expected. The most obvious changes are in weight, the waist region, and in abdominal protrusion, as expected.

One unexpected change occurred in the traditional dimension, Tenth Rib Height. On average, there was a significant increase in Tenth Rib Height over the course of pregnancy from Session 1 to Session 5. The ribs flared outward and upward to make room for the growing fetus. As a result, the Tenth Rib Height increased.

The 3-D anthropometric data are very valuable information. They capture the same changes as the traditional measurements, but in 3-D. Traditional anthropometry is one-dimensional, whereas the human body is 3-D. Therefore, modeling which uses traditional anthropometry forces the modeler to use the one-dimensional information to create a 3-D object or person. For this reason, error will be involved.

The whole-body scanner produces a 3-D image, so you have actual 3-D information on a 3-D body. With the 3-D anthropometric data, the spatial relationship of the measurements in 3-D space is known.

The 3-D anthropometric data captures shape, contour, curvature, surface area, and volume information. Three-dimensional surface anthropometry also allows us to capture the spatial relationship between a person and clothing worn or equipment they used. Three-dimensional surface anthropometry allows us to track, for the first time, the shape changes undergone during pregnancy. This tracking was done visually using Radial Difference Mapping, and through statistical analysis called EDMA. Euclidean Distance Matrix Analysis is a coordinate-free approach to the analysis of form through the use of anatomical landmarks placed on the body before scanning. This information can aid in the design of clothing and workstations for pregnant women.

In addition to the shape changes, the postural changes associated with pregnancy were also tracked. This was done by superimposing various combinations of scans for the same subject using the registration process in INTEGRATE. INTEGRATE is a software tool developed in the CARD Laboratory which is used to analyze and visualize 3-D data.

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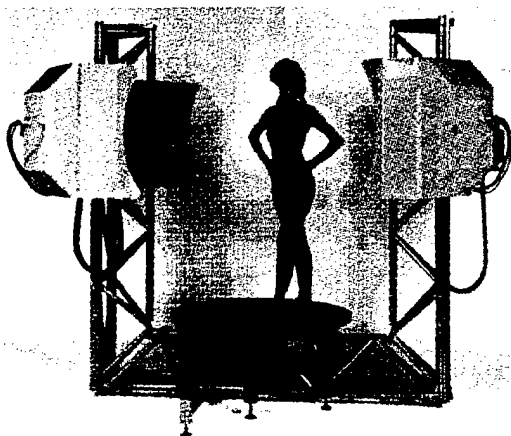
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## **Appendix A: Advertising Brochure**



### ***Three Dimensional Anthropometric Data***

Researchers will use the Cyberware WB4 Whole Body Scanner (shown above) to collect your three-dimensional data. A typical scan takes less than 20 seconds. The scanner uses three-dimensional digitizers to capture surface shape and color information on the human body to create a 3-D image. To date, there is no other 3-D anthropometric data on pregnant women! This type of data provides the *shape* information designers need to help accommodate pregnant women.

## **Pregnant Women needed as volunteers:**



Pregnant women are needed as volunteers for a study at Wright-Patterson Air Force Base that addresses body size and shape changes associated with pregnancy.

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**Qualified subjects will be paid \$8.00 an hour. If you are interested please contact:**

**TERESA CRASE  
255-0865**

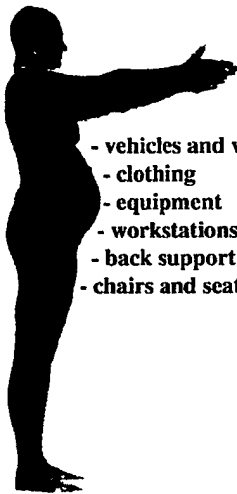
### ***Qualifications***

We need women who are are:

- 18-40 years of age
- active duty military or civilian
- any race/ethnic background
- in their first trimester (before any noticeable weight and/or body changes occur)



The data collected will be applied to help accommodate pregnant women in many different areas of design including:



- vehicles and vehicle constraints
- clothing
- equipment
- workstations and workplaces in general
- back support systems
- chairs and seating



### ***Traditional Anthropometric Data***

Anthropometry is the measurement of the human body. Researchers will use traditional measuring tools (such as the calipers, tape measurers, and anthropometers shown above) to measure a number of dimensions on your body. This type of data provides the *size* information designers need to help accommodate pregnant women.

## **Appendix B: *Skywrighter* Articles**



## NEWS BRIEFS

### Pregnant women studied

The Accommodation and Occupational Safety for Military Personnel research study needs pregnant women to volunteer. The goal is to address the body size and shape changes associated with pregnancy. Volunteers should be between 18 and 40 years old, within Air Force height and weight standards, active duty military or civilian, of any race or ethnic background, and in their first trimester of pregnancy before any noticeable weight or body changes occur. The data will be applied to help accommodate pregnant women in different areas of design including vehicles and clothing. For more information, call Teresa Crase at 235-0665.



## Researchers scan changes during pregnancy

by Patrick Fies  
Sytronics Inc.  
and Bobbie Nixon Jr.  
ASC Public Affairs

**H**ow is a woman's ability to work affected by pregnancy? How late in her pregnancy can she reach, bend and stretch to complete her workday tasks? How can a pregnant woman's job be made easier?

Working under a cooperative research and development agreement, the Fitts Human Engineering Division of the Air Force Research Laboratory here and Sytronics Inc. of Dayton are helping to answer these questions with the first pregnancy study to use three-dimensional computer scanning to track the changes in a woman's body size and shape during pregnancy.

Cooperative research and development agreements are administrative tools that call for government agencies to share federally funded research and development with the private sector.

The pregnancy research is being sponsored by an Army medical and Air Force Materiel Command research grant.

Called the Pregnant Women's

Study, the research measures women throughout the stages of their pregnancy using the world's first, whole-body-scanning system. A research tool used by the Human Engineering Division's computerized anthropometric research and design laboratory, the WB4 Color Whole Body 3-D Scanner gathers measurements and surface information about the entire human body with a single scan in just 19 seconds.

During measurement and scanning sessions, researchers use tape measures and calipers to record a participant's body size. To collect data on body shape, technicians use the whole body scanner.

The study's participants are scanned six times over nine months, so researchers can examine their bodies' changes in each trimester. They also are scanned once after delivery to determine any additional changes.

"The scans are the centerpiece of the study," explained Teresa Crase, a biomedical engineer with Sytronics. "They give us an extremely accurate picture of the subject's shape. We can apply this data to clothing design, equipment design, workstation design — anything a

pregnant woman might wear or use. When we're done, we'll have a useful, 3-D database on pregnant women. It will be the only 3-D data on pregnant women anywhere in the world."

Each scan will be saved in the lab's database, and can be retrieved and studied for other research projects.

"I can see the scans being used to study shape changes for health reasons in medical studies," said lab director Kathleen Robinette, explaining the research's future benefits. "The medical community has taken measurements to study weight gain during pregnancy, but they haven't looked at shape changes."

Sytronics worked with the obstetrics department at the Wright-Patterson Medical Center, and local doctors' offices to find pregnant women to participate as test subjects. Around 33 pregnant women are involved in the study. Of those involved, 21 are civilians and 12 are military.

"Most of the subjects are civilians, but the majority of those civilians are linked to Wright-Patterson as spouses," Crase said. She and another engineer, Barbara McQuis-

ton, head the study for Sytronics.

"We focused our recruiting efforts on the Wright-Patterson Medical Center because women there had greater access to the laboratory," Crase said. "However, we selected only those research subjects who met military height and weight requirements so that the data could be used by the study's sponsors."

"For the Air Force, we're looking at changes we could make in the workplace to keep military women comfortable, longer," said Robinette. "For example, leaning back in seated postures will be studied." The test subjects will be scanned both standing and seated.

One test subject, a civilian participant, Susan Hudson of Glendale whose husband, Jeff, works in Wright Laboratory here, is expecting a baby boy on Aug. 7.

"It's a unique opportunity to be able to see, step-by-step, how my body changes during my pregnancy," she said after her second measuring session. "At the last session I got to compare my previous scans, and I could see exactly where I'm growing. It's really interesting."

The study is scheduled to be completed in August 1990.

## **Appendix C: Payroll Record Form**





## **Appendix D: Landmarks, Dimensions, and Glossary of Terms**

## THE ANTHROPOMETRY

### D-1. MARKED LANDMARKS (In Marking Order)

#### Standing:

1. Axilla (8)
2. Bustpoint (2)
3. Substernale
4. Tenth Rib (2)
5. Waist Level, Preferred (8)
6. Waist Level, Omphalion (8)
7. PSIS (2)
8. ASIS (2)
9. Illiocristale (2)
10. Buttock Point (3)
11. Suprapatella (2)
12. Malleolus, Lateral (2)
13. Malleolus, Medial (2)
14. Metatarsal I (2)
15. Metatarsal V (2)

#### Sitting:

16. Tragion (2)
17. Infraorbitale (2)
18. Suprasternale
19. Cervicale
20. Spine<sup>1</sup> (4)
21. Acromion (2)

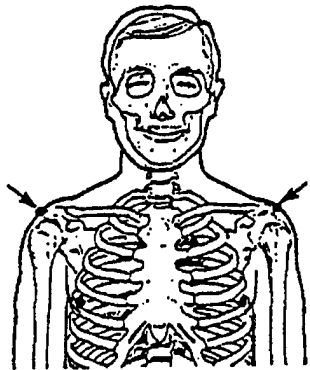
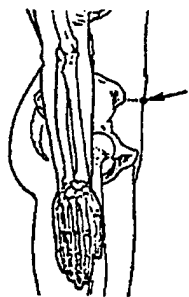
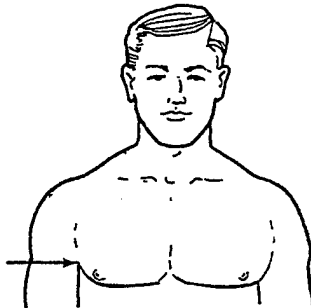
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<sup>1</sup> Spine landmarks will be established on the center of the spine at 10 cm intervals from cervicale.

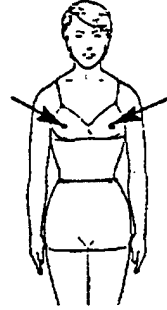
- 22. Humeral Epicondyles (4)
- 23. Radial Stylium (2)
- 24. Ulnar Stylium (2)
- 25. Metacarpale II (2)
- 26. Metacarpale V (2)
- 27. Femoral Epicondyles (4)

D-2.

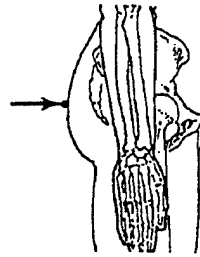
**LANDMARK DESCRIPTIONS** (In Alphabetical Order)

<p><b>1. Acromion:</b> The most lateral point on the acromial process of the scapula. Both right and left acromion are landmarked.</p>	
<p><b>2. ASIS (Anterior Superior Iliac Spine):</b> The uppermost of two pair of prominences (the other is the anterior inferior iliac spine) on the anterior rims of the ilia. (The ilia are one of the three pair of bones which comprise the bony pelvis). Both right and left ASIS are landmarked.</p>	
<p><b>3. Axilla:</b> The armpit, the lowest point of the crease which forms on the front of the body at the axilla (the armpit) when the upper arm is relaxed against the chest. Both right and left axilla are landmarked.</p>	

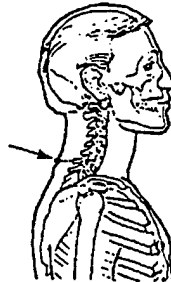
4. **Bustpoint:** The most anterior protrusion of the right and left bra pocket. Both right and left bustpoint are landmarked.



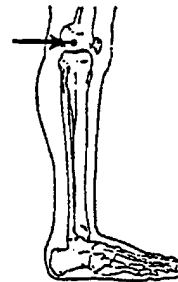
5. **Buttock Point:** The maximum posterior protrusion of the right buttock.

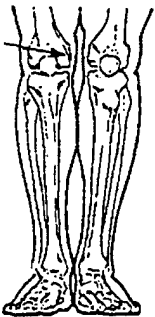
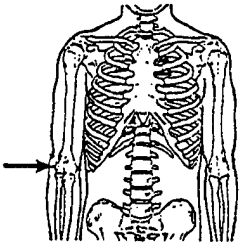
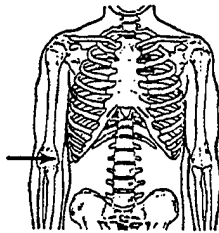
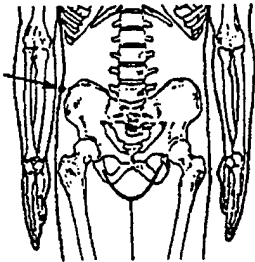


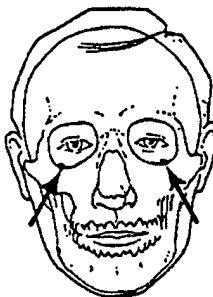
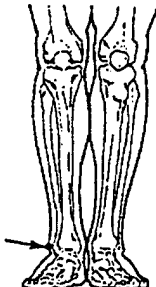
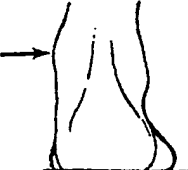
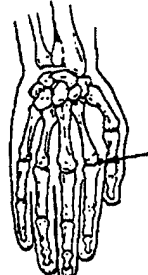
6. **Cervicale:** The superior tip of the spine of the 7<sup>th</sup> cervical vertebra, generally characterized by a protrusion of the spinal column at the base of the neck.

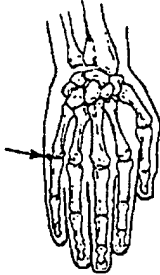
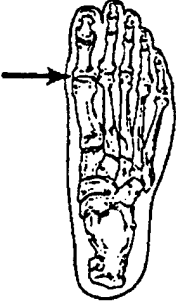
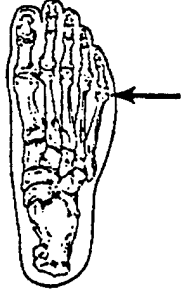
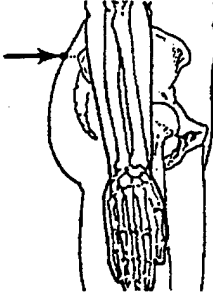


7. **Lateral Femoral Epicondyle:** The bony protuberance at the distal end of the right and left femur. Both right and left lateral femoral epicondyle are landmarked.



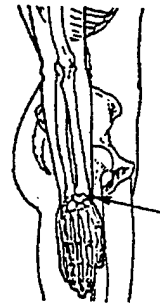
<p><b>8. Medial Femoral Epicondyle:</b> The bony protuberance at the distal end of the right and left femur. Both right and left medial femoral epicondyle are landmarked.</p>	
<p><b>9. Lateral Humeral Epicondyles:</b> The bony protuberance at the distal end of the right and left humerus. Both right and left lateral humeral epicondyle are landmarked.</p>	
<p><b>10. Medial Humeral Epicondyles:</b> The bony protuberance at the distal end of the right and left humerus. Both right and left medial humeral epicondyle are landmarked.</p>	
<p><b>11. Iliocristale:</b> Title for the superior rim of the ilium in the right and left mid-lateral lines. Both right and left illiocristale are landmarked.</p>	

<p><b>12. Infraorbitale:</b> The lowest point on the inferior margin of the orbit or bony eye socket, directly inferior to the pupil. Both right and left infraorbitale are landmarked.</p>	 <p>A line drawing of a human face from the front. Two arrows point to the lowest point of the bony eye socket, directly below the pupils, indicating the infraorbitale landmark.</p>
<p><b>13. Malleolus, Lateral:</b> The lateral bony protrusion of the ankle; the most lateral point on the lateral bony protrusion of the ankle. Both right and left lateral malleolus are landmarked.</p>	 <p>A line drawing of the lower legs and ankles from the front. An arrow points to the lateral bony protrusion of the ankle, indicating the lateral malleolus landmark.</p>
<p><b>14. Malleolus, Medial:</b> The medial bony protrusion of the ankle; the most medial point on the medial bony protrusion of the ankle. Both right and left medial malleolus are landmarked.</p>	 <p>A line drawing of the lower leg and ankle from the side. An arrow points to the medial bony protrusion of the ankle, indicating the medial malleolus landmark.</p>
<p><b>15. Metacarpale II:</b> The most protruding point on the lateral edge of the bony prominence (knuckle) formed by the joint between the second metacarpal and phalanx of the second (pointer) finger. Both right and left metacarpale II are landmarked.</p>	 <p>A line drawing of a human hand from the back. An arrow points to the most protruding point on the lateral edge of the knuckle of the second (pointer) finger, indicating the Metacarpale II landmark.</p>

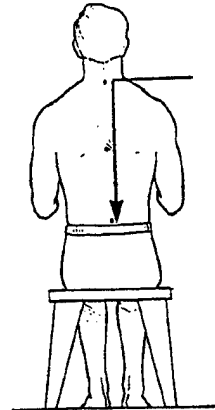
<p><b>16. Metacarpale V:</b> The most protruding point on the lateral edge of the bony prominence (knuckle) formed by the joint between the fifth metacarpal and phalanx of the fifth (pinkie) finger. Both right and left metacarpale V are landmarked.</p>	
<p><b>17. Metatarsal I:</b> The joint formed between the bones of the foot and the first bone of the big toe; the "ball-of-the-foot." Both right and left metatarsal I are landmarked.</p>	
<p><b>18. Metatarsal V:</b> The joint formed between the bones of the foot and the first bone of the little toe. Both right and left metatarsal V are landmarked.</p>	
<p><b>19. PSIS (Posterior Superior Iliac Spine):</b> The point on the mid-spine made at the level of the posterior superior iliac spines. A dimple often indicates the site of the iliac spine. Both right and left PSIS are landmarked.</p>	



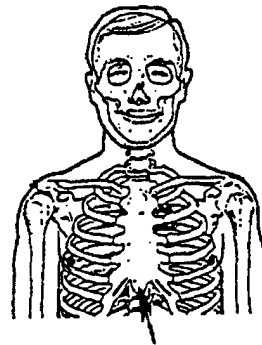
**20. Radial Styliion:** The tip of the styloid process at the distal end of the radius, on the thumb side of the wrist. Both right and left radial styliion are landmarked.



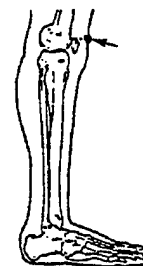
**21. Spine:** Landmarks located on the center of the spine at 10 cm intervals from cervicale. The number of spine landmarks vary according to the length of the individual's torso. (In general, subjects with longer torsos have four spine landmarks, and subjects with shorter torsos have three).



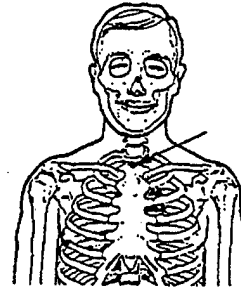
**22. Substernale:** The middle of the lower end of the breastbone.



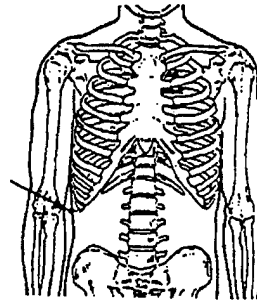
**23. Suprapatella:** The top of the kneecap; the superior point on the patella while it is in the relaxed (loose) position. Both right and left suprapatella are landmarked.



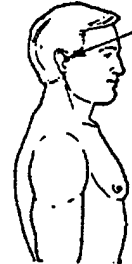
**24. Suprasternale:** The lowest point of the (jugular) notch at the upper end of the breastbone (sternum).



**25. Tenth Rib:** The lowest point on the inferior border of the tenth (lowest palpable) rib. Both right and left tenth rib are landmarked.



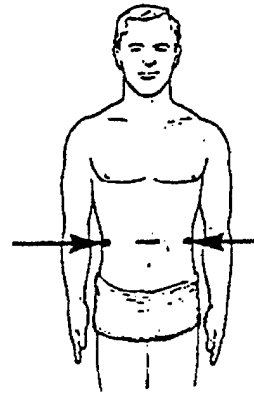
**26. Tragion:** A point at the notch just above the tragus of each ear. This point corresponds (approximately) to the upper edge of the ear hole. Both right and left tragion are landmarked.



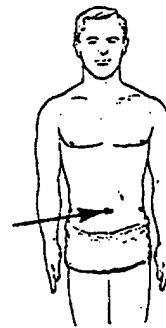
**27. Ulnar Styloid:** The most distal point of the right and left ulna. Both right and left ulnar styloid are landmarked.



**28. Waist Level, Preferred:** The level of the waist established by the subject placing an elastic tape at his or her preferred waist level. The preferred waist level is landmarked four times: on the front, on the back, on the right and on the left.



**29. Waist Level, Omph:** The waist at the level of navel (umbilicus). The waist level at omphalion is landmarked four times: on the front, on the back, on the right and on the left.



D-3.        **DIMENSION LIST** (In Measurement Order)

1.     Thumbtip Reach, Right
2.     Weight
3.     Stature
4.     Cervicale Height
5.     Suprasternale Height
6.     Substernale Height
7.     Chest Height
8.     Chest Height Below Bust
9.     Tenth Rib Height
10.    Waist Height, Preferred
11.    Waist Height, Omphalion
12.    Patella Top Height<sup>2</sup>
13.    Chest Breadth
14.    Chest Breadth Below Bust
15.    Waist Breadth, Preferred
16.    Waist Breadth, Omphalion
17.    Hip Breadth
18.    Chest Depth
19.    Chest Depth Below Bust
20.    Waist Depth, Preferred
21.    Waist, Depth, Omphalion
22.    Chest Circumference
23.    Chest Circumference Below Bust
24.    Waist Circumference, Preferred
25.    Waist Circumference, Omphalion
26.    Hip Circumference

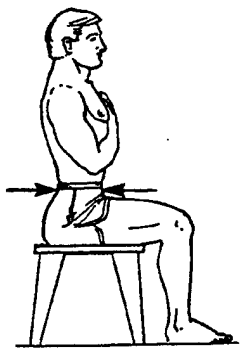
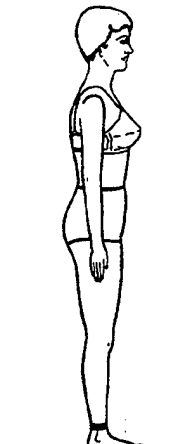

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<sup>2</sup> *Knee Height measured at suprapatella.*

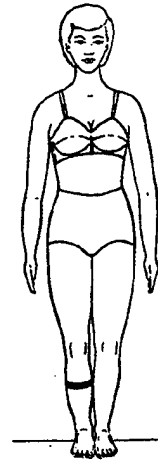
27. Thigh Circumference, Proximal
28. Calf Circumference
29. Ankle Circumference
30. Foot Breadth
31. Sitting Height
32. Cervicale Height, Sitting
33. Knee Height, Sitting
34. Buttock-Knee Length
35. Abdominal Extension Depth, Sitting
36. Hip Breadth, Sitting
37. Hand Breadth

D-4.

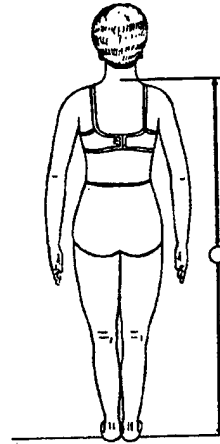
**DIMENSION DESCRIPTIONS** (In Alphabetical Order)

<p><b>1. Abdominal Extension Depth, Sitting:</b> The subject sits erect on a flat surface looking straight ahead. The abdominal muscles are relaxed. The horizontal distance is measured between the back and the most protrusive point of the abdomen.</p>	
<p><b>2. Ankle Circumference:</b> The subject stands with the weight distributed equally on both feet. The minimum circumference of the right ankle above the ankle bone is measured.</p>	
<p><b>3. Buttock-Knee Length:</b> The subject sits erect on a flat surface looking straight ahead. The thighs are parallel, and the feet are in line with the thighs on a surface adjusted so that the knees are bent 90 degrees. The horizontal distance is measured between the most protrusive point of the right buttock and the most forward point of the knee.</p>	

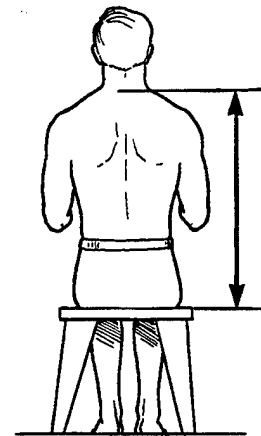
**4. Calf Circumference:** The subject stands with the weight distributed equally on both feet. The maximum circumference of the right lower leg is measured perpendicular to its long axis.



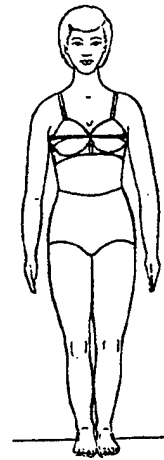
**5. Cervicale Height:** The subject stands erect looking straight ahead with the head in the Frankfurt Plane. The arms hang relaxed at the sides, and the heels are together with the weight distributed equally on both feet. The vertical distance is measured between the standing surface and the top of the spine of the 7<sup>th</sup> cervical vertebra (cervicale).



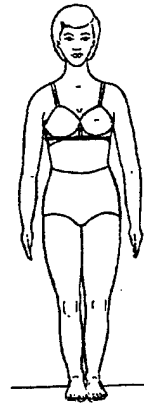
**6. Cervicale Height, Sitting:** The subject sits erect on a flat surface looking straight ahead with the head in the Frankfurt Plane. The shoulders and upper arms are relaxed and the forearms and hands are extended forward horizontally with the palms facing each other. The thighs are parallel and the knees are bent 90 degrees. The vertical distance between a sitting surface and the cervicale landmark is measured.



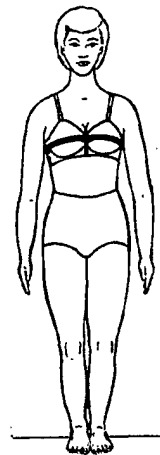
**7. Chest Breadth:** The subject stands erect looking straight ahead. The arms hang relaxed at the sides. The horizontal breadth of the chest is measured at the level of the most protrusive right point and most protrusive left point of the bra.



**8. Chest Breadth Below Bust:** The subject stands erect looking straight ahead. The arms hang relaxed at the sides. The horizontal breadth of the chest is measured just below the bust.

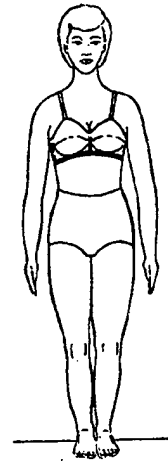


**9. Chest Circumference:** The subject stands erect looking straight ahead. The arms hang relaxed at the sides. The horizontal circumference of the chest is measured at the level of the most protrusive point of the right and left bra pocket.

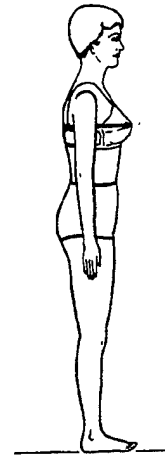




**10. Chest Circumference Below Bust:** The subject stands erect looking straight ahead. The arms hang relaxed at the sides. The horizontal circumference of the chest is measured just below the bust.

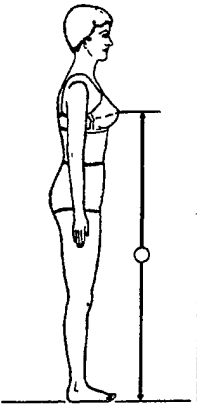
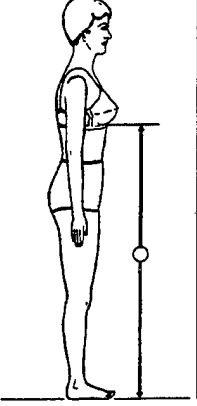

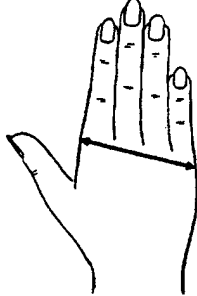


**11. Chest Depth:** The subject stands erect looking straight ahead. The arms hang relaxed at the sides. The horizontal depth of the chest is measured from the front to back at the level of the most protrusive point of the right bra pocket.

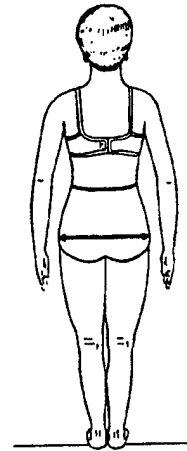


**12. Chest Depth Below Bust:** The subject stands erect looking straight ahead. The arms hang relaxed at the sides. The maximum horizontal depth of the chest is measured just below the bust.

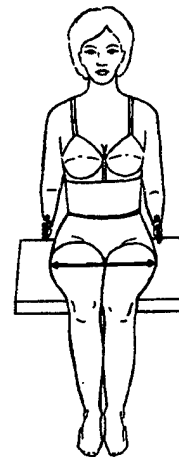


<p><b>13. Chest Height:</b> The subject stands erect looking straight ahead. The arms hang relaxed at the sides, and the heels are together with the weight distributed equally on both feet. The vertical distance is measured between the standing surface and the most protrusive point of the right bra pocket.</p>	
<p><b>14. Chest Height Below Bust:</b> The subject stands erect looking straight ahead. The arms hang relaxed at the sides, and the heels are together with the weight distributed equally on both feet. The vertical distance is measured between the standing surface and just below the bust.</p>	
<p><b>15. Foot Breadth:</b> The subject stands with the weight distributed equally on both feet. The maximum horizontal distance across the right foot is measured perpendicular to its long axis.</p>	
<p><b>16. Hand Breadth:</b> The right hand is held palm down. The fingers are straight and touching and the thumb is held slightly away from the side of the hand. The straight-line distance across the hand is measured between the sides of the knuckles at the first and little fingers at the points of their greatest protrusion (metacarpale) at the sides of the hand.</p>	

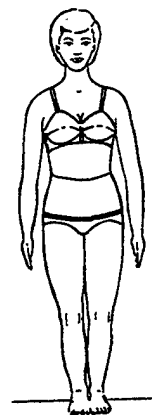
**17. Hip Breadth:** The subject stands erect looking straight ahead. The arms hang relaxed at the sides, and the heels are together with the weight distributed equally on both feet. The maximum horizontal distance is measured across the hips.



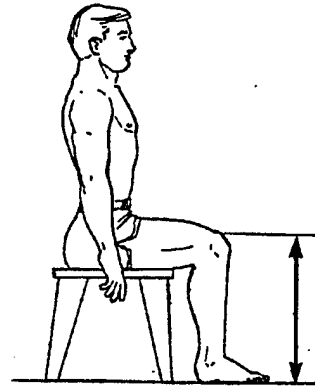
**18. Hip Breadth, Sitting:** The subject sits erect on a flat surface with their knees together. The maximum horizontal breadth is measured across the hips or thighs.



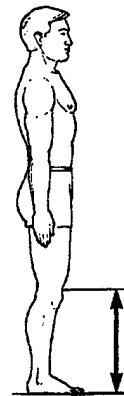
**19. Hip Circumference:** The subject stands erect looking straight ahead. The arms are usually folded at the waist, and the heels are together with the weight distributed equally on both feet. The level of the buttock point landmark was transferred to the subject's right and left side using an anthropometer. The horizontal circumference of the hips is measured at the level of the maximum protrusion of the buttock.



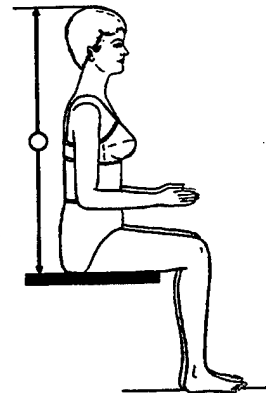
**20. Knee Height, Sitting:** The subject sits erect on a flat surface. The thighs are parallel, and the feet are in line with the thigh on a surface adjusted so that the knees are bent 90 degrees. The vertical distance is measured between the foot rest and the suprapatella landmark at the top of the right knee.



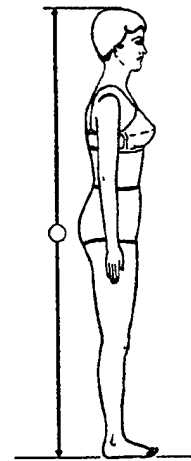
**21. Patella Top Height:** The subject stands erect looking straight ahead. The arms hang relaxed at the sides, and the heels are together with the weight distributed equally on both feet. The vertical distance is measured between the standing surface and the right suprapatella landmark.



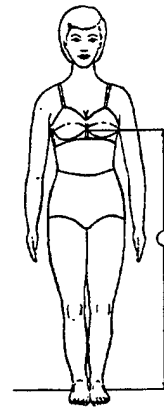
**22. Sitting Height:** The subject sits erect on a flat surface looking straight ahead with the head in the Frankfurt Plane. The shoulders and upper arms are relaxed and the forearms and hands are extended forward horizontally with the palms facing each other. The vertical distance is measured between the sitting surface and the top of the head.



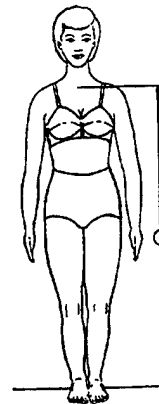
**23. Stature:** The subject stands erect looking straight ahead with the head in the Frankfurt Plane. The arms hang relaxed at the sides, and the heels are together with the weight distributed equally on both feet. The vertical distance is measured between the standing surface and the top of the head.



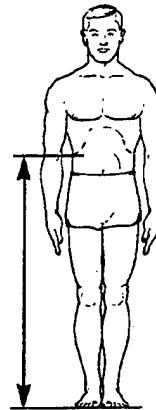
**24. Substernale Height:** The subject stands erect looking straight ahead. The arms hang relaxed at the sides, and the heels are together with the weight distributed equally on both feet. The vertical distance is measured between the standing surface and the lowest point (substernale) of the sternum.



**25. Suprasternale Height:** The subject stands erect looking straight ahead with the head in the Frankfurt Plane. The arms hang relaxed at the sides, and the heels are together with the weight distributed equally on both feet. The vertical distance is measured between the standing surface and the lowest point of the notch at the upper end of the sternum.



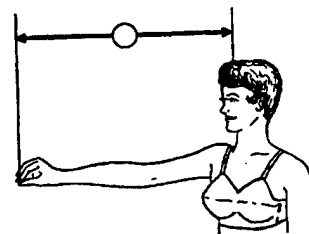
**26. Tenth Rib Height:** The subject stands erect looking straight ahead. The heels are together with the weight distributed equally on both feet. The vertical distance is measured between the standing surface and the right tenth rib landmark.



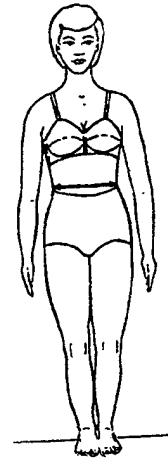
**27. Thigh Circumference, Proximal:** The subject stands with the legs apart just enough that the inner thighs do not touch. The weight is distributed equally on both feet. The circumference of the right thigh is measured perpendicular to its long axis at the lowest point of the thigh/buttock juncture.



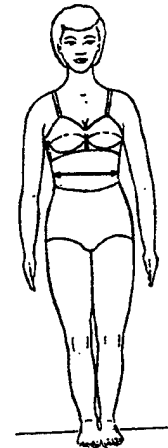
**28. Thumbtip Reach:** The subject stands erect with the heels 10 cm apart and her back against a wall. The heels, the buttocks, and the shoulder blades touch the wall. The right arm is straight and held forward horizontally. The tip of the index finger touches the pad of the thumb which is held in line with the long axis of the forearm and hand. The horizontal distance is measured between the wall and the tip of the thumb.



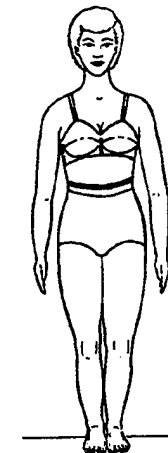
**29. Waist Breadth, Omphalion:** The subject stands erect looking straight ahead with the arms hanging relaxed at the sides. The horizontal breadth of the torso is measured at the level of the center of the navel (omphalion).



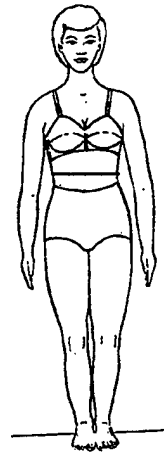
**30. Waist Breadth, Preferred:** The subject stands erect looking straight ahead with the arms hanging relaxed at the sides. The horizontal breadth of the torso is measured at the level established by the subject placing an elastic tape at her preferred waist level.



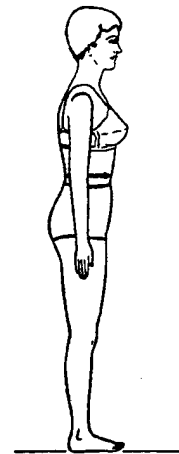
**31. Waist Circumference, Omphalion:** The subject stands erect looking straight ahead. The upper arms hang relaxed at the sides, and the abdominal muscles are relaxed. The maximum horizontal circumference of the waist is measured at the level of omphalion.



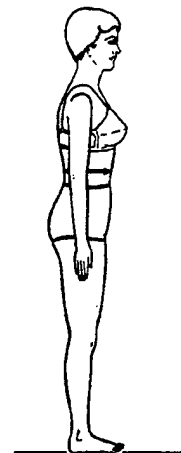
**32. Waist Circumference, Preferred:** The subject stands erect looking straight ahead. The upper arms hang relaxed at the sides, and the abdominal muscles are relaxed. The maximum horizontal circumference of the waist is measured at the level of the preferred waist.



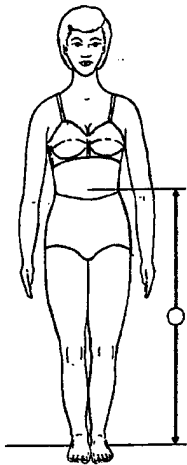
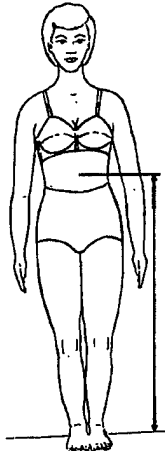
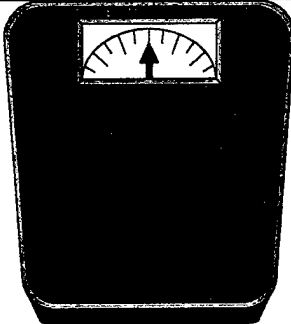
**33. Waist Depth, Omphalion:** The subject stands erect looking straight ahead. The upper arms hang relaxed at the sides, and the abdominal muscles are relaxed. The horizontal distance is measured between the subject's back and the center of omphalion.



**34. Waist Depth, Preferred:** The subject stands erect looking straight ahead. The upper arms hang relaxed at the sides, and the abdominal muscles are relaxed. The horizontal distance is measured between the subject's back and the level of the preferred waist.





<p><b>35. Waist Height, Omphalion:</b> The subject stands erect looking straight ahead. The upper arms hang relaxed at the sides, and the abdominal muscles are relaxed. The maximum vertical distance is measured between the standing surface and the center of omphalion.</p>	
<p><b>36. Waist Height, Preferred:</b> The subject stands erect looking straight ahead. The upper arms hang relaxed at the sides, and the abdominal muscles are relaxed. The maximum vertical distance is measured between the standing surface and the level of the preferred waist.</p>	
<p><b>37. Weight:</b> The nude<sup>3</sup> subject stands on a scale with her feet parallel and the weight distributed equally on both feet.</p>	

<sup>3</sup> "Nude" subjects are not literally nude; they are clad in lightweight garments similar to biking shorts and a sport bra.

**GLOSSARY OF RELATED TERMS****Orientation Terminology**

1.     **Anterior:** Pertaining to the *front* of the body, as opposed to posterior.
2.     **Posterior:** Pertaining to the *back* of the body, as opposed to anterior.
3.     **Lateral:** Lying near or toward the *sides* of the body; located to the right or left of the vertical fore-and-aft midline (the midsagittal plane) of a bilaterally symmetrical body. The opposite of lateral is medial.
4.     **Medial:** Lying near or toward the *midline* of the body; toward the *midsagittal plane*; the opposite of lateral.
5.     **Superior:** Above, in relation to another structure; higher.
6.     **Inferior:** Below, in relation to another structure; lower.
7.     **Proximal:** The end of a body segment *nearest* to the head; nearest a point of origin; *nearest the head or torso*. The opposite of proximal is distal.
8.     **Distal:** The end of a body segment *farthest* from the head; away from the point of origin; *away from the head or torso*. The opposite of distal is proximal.

9. **Frankfort Plane:** The standard horizontal plane or orientation of the head. The plane is established by a line passing through the right trignon (approximately, above the hole of the ear) and the right orbit (eye socket).

#### Common Prefixes

1. **Sub-:** A prefix designating below, or under.
2. **Supra-:** A prefix designating above, or on.
3. **Infra-:** Below, beneath, or inferior to.

#### General Information

1. **Acromiale:** Acromion.
2. **Ilia:** One of the three pairs of bones which comprise the bony pelvis; plural of Ilium.
3. **Iliac:** Of, referring to, or located near the Ilium.
4. **Ilium:** The upper of the three pairs of bones composing either lateral half (right or left) of the pelvis (the other pairs of bones are the ischium and pubis).
5. **Ischium:** The lowest of the three major bones which comprise each half of the bony pelvis.
6. **Meatus:** A body canal or passage.

7. **Midsagittal Plane:** The vertical plane which divides the body into right and left halves.
8. **Orbit:** The bony eye socket.
9. **Palpate:** Examination by touch. Anatomical landmarks are located either by palpation or by visual inspection.
10. **Process:** A part extending from an organ or organism: an appendage. [*Example 1:* The acromial process extends from the top of the scapula. *Example 2:* The styloid process is a body protuberance resembling a stylus at the distal ends of the radius and ulna].
11. **Protuberance:** That which protrudes; a bulge or knob; a protrusion.
12. **Protrusion:** That which protrudes; a bulge or knob; a protuberance.
13. **Pubis:** The front or forward section of the bony pelvis; the last of the three bones which comprise each half of the bony pelvis.
14. **Scapula:** The shoulder blade.
15. **Sternum:** The breast bone.
16. **Tragus:** The small cartilaginous flap in front of the external auditory meatus of the skull (the ear hole).

17. **Umbilicus:** The navel. Omphalion is the corresponding landmark name.
18. **USA:** Abbreviation for the United States Army.
19. **USAF:** Abbreviation for the United States Air Force.
20. **USN:** Abbreviation for the United States Navy.

#### Description of Dimension Types

1. **Height** is a straight line, point-to-point vertical measurement.
2. **Breadth** is a straight line, point-to-point horizontal measurement running across the body or a segment.
3. **Depth** is a straight line, point-to-point horizontal measurement running from ventral (front) to dorsal (back).
4. **Circumference** is a closed measurement that follows a body contour; this measurement may not be circular.
5. **Reach** is a point-to-point measurement following the long axis of the arm or leg.

## **Appendix E: Completion Questionnaire**

SUBJECT NO.: 0742-

(To be completed by SYTRONICS only).

PREGNANT WOMEN'S STUDY

QUESTIONNAIRE

**NOTICE:** The Privacy Act, 5 U.S.C. 552a, requires that federal agencies inform individuals, at the time information is solicited from them, whether the disclosure is mandatory or voluntary, by what authority such information is solicited, and what uses will be made of the information. You are hereby advised that authority for soliciting the following voluntary information is Grant No.: DAMD 17-96-1-6311 and that all information provided will be used strictly for research purposes only. All personal information will be kept strictly **CONFIDENTIAL**.

A PERSONAL DATA		
NAME:	DATE:	
ADDRESS:	WORK PHONE:	HOME PHONE:

**RACE/ETHNIC BACKGROUND:** According to the **RACE/ETHNIC BACKGROUND** descriptions explained below, please identify the mother's race, father's race, and baby's race by placing the corresponding number in the appropriate block.

- #1. **WHITE** (Not of Hispanic Origin): All persons having origins in any of the original peoples of Europe, North Africa, or the Middle East.
- #2. **BLACK** (Not of Hispanic Origin): All persons having origins in any of the Black racial groups of Africa.
- #3. **HISPANIC**: All persons of Mexican, Puerto Rican, Central or South American or other Spanish culture or origin, regardless of race (includes those with Hispanic surnames).
- #4. **AMERICAN INDIAN OR ALASKA NATIVE**: All persons having origins in any of the original peoples of North America, and who maintain cultural identification through tribal affiliation or community recognition.
- #5. **ASIA OR PACIFIC ISLANDER**: All persons having origins in any of the original peoples of the Far East, Southeast Asia, the Indian Subcontinent, or the Pacific Islands. This area includes, for example, China, Japan, Korea, the Philippine Islands, and Samoa.
- #6. **OTHER**: Please specify.

BABY'S MOTHER	BABY'S FATHER	BABY'S
Race/Ethnic Background No.: <input type="checkbox"/>	Race/Ethnic Background No.: <input type="checkbox"/>	Race/Ethnic Background No.: <input type="checkbox"/>
NOTE: If #6, please identify here:	NOTE: If #6, please identify here:	NOTE: If #6, please identify here:
OTHER: _____	OTHER: _____	OTHER: _____

ABOUT YOUR PREGNANCY(s)	
HOW FAR ALONG ARE YOU?  Months	DUE DATE:
NUMBER OF PREVIOUS LIVE BIRTHS:	NUMBER OF PREGNANCIES (Including this one):

SUBJECT NO.: 0742-

(To be completed by SYTRONICS only).

644

(B)

OCCUPATION

AFSC:

JOB TITLE:

PLEASE CIRCLE ONE

1.	Do you smoke? If YES, how many cigarettes do you smoke per day?	YES	NO
2.	Has this changed since you became pregnant? If YES, how?	YES	NO
3.	Is your job a desk or non-desk job?	DESK	NON-DESK
4.	How many hours do you work in one day?		
5.	How many hours do you work in one week?		
6.	Do you stand, sit, or both stand and sit on the job?	STAND	SIT BOTH

IF YOU STAND ON THE JOB, GO TO QUESTION 7.

IF YOU SIT ON THE JOB, GO TO QUESTION 8.

IF YOU STAND AND SIT ON THE JOB, ANSWER BOTH QUESTION 7 AND 8.

7. If your job is done primarily standing, then:

(a) Please describe your work area. Specifically address where you stand, whether your table/desk/workstation is adjustable, etc. Please be as descriptive as possible.

is b

*Example: I work in an office which handles money, cashier tills, accounting, etc. The room is approximately 25 feet long and 8 feet wide. There is a large vault at one end of the room which has a large, heavy door. I stand at a counter which is between 3 feet and 4 feet tall. The counter is a fixed height and does not adjust. I periodically move to other parts of the room to answer the telephone, go into the vault, etc.*

(b) How many hours per day do you actually stand? \_\_\_\_\_

OK, what percentage (%) of the time do you stand while you work? \_\_\_\_\_

(c) How long do you work in a standing position at one time (5 minutes, 30 minutes, 1 hour, etc.)? \_\_\_\_\_

(d) Do you operate machinery while you are standing? \_\_\_\_\_

If YES, please explain in detail what type of machine you work with or operate.

(Continued on next page).



SUBJECT NO.: 0742-

(To be completed by SYTRONICS only).

7. (Cont'd)

(a) While standing, do you lift any type of object(s)?

If YES, approximately how much do the objects weigh?

What size are the objects?

How often do you lift the object(s) (5 times/hour, etc.)?

8. If your job is done primarily sitting, then:

(a) Please describe your work area. Specifically address where you sit, whether your seat or workstation is adjustable, etc. Please be as informative as possible.

*Example: I work in a huge room which has a number of desks lined up in rows. There are partitions between each desk which act as walls. The cubes are very small, approximately 8 feet by 6 feet. The chair in which I sit adjusts in height as well as the angle at which I sit.*

(b) How many hours per day do you actually sit?

OR, what percentage (%) of the time do you sit while you work?

(c) How long do you work in a sitting position at one time (5 minutes, 30 minutes, 1 hour, etc.)?

(d) Do you operate machinery while you are sitting?

If YES, please explain in detail what type of machine or device you work with or operate.

(e) While sitting, do you lift any type of object(s)?

If YES, approximately how much do the objects weigh?

What size are the objects?

How often do you lift the object(s) (5 times/hour, etc.)?

PLEASE COMPLETE THE REST OF THE QUESTIONNAIRE,  
WHICH INCLUDES QUESTIONS 9-16.

Page 3

SUBJECT NO.: 0742-

(To be completed by SYTRONICS only).

PLEASE CIRCLE ONE

9. During the work day, do you ever have difficulty reaching for an object or objects with one arm? YES NO

If YES, how far do you think you reach? \_\_\_\_\_

Do the object(s) you reach for have good handles, grips, etc.? \_\_\_\_\_

Which direction(s) do you typically reach (up, to the left, etc.)? \_\_\_\_\_

10. During the work day, do you ever have difficulty reaching for an object or objects with both arms? YES NO

If YES, how far do you think you reach? \_\_\_\_\_

Do the object(s) you reach for have good handles, grips, etc.? \_\_\_\_\_

Which direction(s) do you typically reach (up, to the left, etc.)? \_\_\_\_\_

11. Do you perform any typing tasks? YES NO

If YES, is there a wrist pad in front of the keyboard? \_\_\_\_\_

How many hours of the day do you spend typing? \_\_\_\_\_

12. Do you take breaks? YES NO

If YES, how often do you take breaks? \_\_\_\_\_

How long does each break last? \_\_\_\_\_

13. Do you break for a lunch? YES NO

If so, how long? \_\_\_\_\_

14. Considering your work environment, do you foresee pregnancy hindering or limiting your job performance in any way? YES NO

Please explain your answer.

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

0742.

by SYTRONICS only).

THE FOLLOWING QUESTIONS ARE OPTIONAL

- NO

[illegible]

- [illegible]

## **Appendix F: Consent Forms**

Investigator Name: Barbara K. McQuiston  
Address: 4433 Dayton-Xenia Rd; Bldg 1  
Dayton OH 45432-1949  
Telephone No.: (937) 429-1466, Ext 106

## PROTOCOL 83-30

(Version 1.2/04 October 96)

INFORMATION PROTECTED BY THE PRIVACY ACT OF 1974

### Consent Form

**TITLE: ACCOMMODATION AND OCCUPATIONAL SAFETY FOR PREGNANT MILITARY PERSONNEL**

1. I have been invited to participate in an experiment during which a number of dimensions will be measured on my body. I further understand that these measurements will be used in the sizing and design of clothing, personal-protective equipment, or aircraft and ground equipment crew stations.

2. Participation in this study is restricted to currently pregnant females between the ages of 18-40 years of age.

3. If I decide to participate, I understand that these measurements will be used to describe the lengths, breadths, depths, circumferences, and surface contours of my body and its major segments. To aid in this process, measuring marks will be placed on my body with a water-soluble colored pencil and/or gummed-back stickers; however, these marks will be removed after measuring is completed. I also understand that the measurements may be made with several traditional advanced measuring tools. The traditional tools are an anthropometer (which is similar to a yard stick), tape measures, and various types of calipers (e.g., beam and spreading calipers). The advanced tools include digital head and whole body scanning systems which project a line of light from low-powered lasers onto the surface of my skin. This light will be digitally recorded by a video camera as the camera/laser assemblies rotate horizontally or translate vertically around me while I am measured with the head or whole body scanner, respectively. After discussing my participation in this study with study investigators, I understand that many thousands of men and women have already been measured using the digital head scanning system with no adverse effects. I further understand that hundreds of men and women have been measured using the whole body scanning system with no adverse effects and that there have been no adverse effects or safety issues with repeated scans of subjects.

4. My confidentiality as a participant in this program will be protected. Specifically, this means that my name and Social Security Number will not be stored with or connected with my data. I understand that it may be possible to recognize me from the data collected with the head

Subject's Initials: _____	Witnesses Initials: _____
Date: _____	Date: _____

and whole body scanners, since these data are essentially a digital photograph. Also, I understand that all human body measurement data collected on me, including the scanned data, may be released to the public. I give my consent to release this information. Again, this release will be done without including my name or Social Security Number. I realize that once the data are released, they may be used for purposes other than those Armstrong Laboratory intended.

5. If I decide to participate, I am free to withdraw my consent and to discontinue participation at any time without prejudice to my future relations with Armstrong Laboratory. If I have any questions, I understand that I may contact:

Kathleen M. Robinette  
AL/CFHD  
Building 248, 2255 H Street  
Wright-Patterson AFB OH 45433-7022  
(513) 255-8810.

6. I, \_\_\_\_\_,

am participating because I want to. The decision to participate in this research study is completely voluntary on my part. No costs will be incurred by me for participation in this study. No one has coerced or intimidated me into participating in this program.

\_\_\_\_\_  
(Insert Name of Briefer, Office Symbol, and Phone Number)

has adequately answered any and all questions I have asked about this study, my participation, and the procedures involved, which are set forth above, which I have read. I understand that the Principal Investigator or a designee will be available to answer any questions concerning procedures throughout this study. I understand that if significant new findings develop during the course of this research which may relate to my decision to continue participation, I will be informed. I further understand that I may withdraw this consent at any time and discontinue further participation in this study. I also understand that the Medical Consultant for this study may terminate my participation in this study if it is felt to be in my best interest.

7. (a) Records of my participation in this study may only be disclosed according to federal law, including the Federal Privacy Act, 5 U.S.C. 552a, and its implementing regulations.
- (b) I understand my entitlements to medical and dental care and/or compensation in the event of injury are governed by federal laws and regulations, and that if I desire further information, I may contact the base legal office--

Subject's Initials: _____	Witnesses Initials: _____
Date: _____	Date: _____

Air Force Materiel Command Judge Advocate General's Office  
General Law Directorate  
AFMC/JAM  
(513) 257-7142.

- (c) If an unanticipated event (medical misadventure) occurs during my participation in this study, I will be informed. If I am not competent at the time to understand the nature of the event, such information will be brought to the attention of my next of kin.
- (d) The decision to participate in this research is completely voluntary on my part. No one has coerced or intimidated me into participating in this program. I am participating because I want to. Dr.--

\_\_\_\_\_

*(insert Name of Investigator, Office Symbol, and Phone Number)*

has adequately answered any and all questions I have about this study, my participation, and the procedures involved. I understand that Dr.--

\_\_\_\_\_

*(insert Name of Investigator, Office Symbol, and Phone Number)*

will be available to answer any questions concerning procedures throughout this study. I understand that if significant new findings develop during the course of this research which may relate to my decision to continue participation, I will be informed. I further understand that I may withdraw this consent at any time and discontinue further participation in this study without prejudice to my entitlements. I also understand that the medical monitor of this study may terminate my participation in this study if he or she feels this to be in my best interest.

- (e) Representatives of the U.S. Army Medical Research and Materiel Command, the funding sponsor of this study, are eligible to review research records as a part of their responsibility to protect human subjects in research.

8. This study will collect anthropometry for pregnant military personnel. These data can benefit the military by being used to evaluate policies and duty assignments for pregnant service women. This is especially important since body size and reach constraints during the latter pregnancy stages could adversely affect occupational performance and safety.

9. I understand that my participation in this study may be photographed, filmed, or audio/video taped. I consent to the use of these media for research and training purposes and understand that any release of records of my participation in this study may only be disclosed according to federal law, including the Federal Privacy Act, 5 U.S.C. 552a, and its implement-

Subject's Initials: _____	Witnesses Initials: _____
Date: _____	Date: _____

ing regulations. This means personal information will not be released to an unauthorized source without my permission.

10. In accordance with 45 CFR 46.207(b) stipulates that the father's consent will be obtained, when possible, in research studies involving pregnant women.

**I FULLY UNDERSTAND THAT I AM MAKING A DECISION WHETHER OR NOT TO PARTICIPATE. MY SIGNATURE INDICATES THAT I HAVE DECIDED TO PARTICIPATE HAVING READ THE INFORMATION PROVIDED ABOVE.**

SUBJECT		FATHER'S CONSENT	
TYPED/PRINTED NAME		TYPED/PRINTED NAME	
ADDRESS: _____		ADDRESS: _____	
Signature	Date	Signature	Date
ADVISING INVESTIGATOR		WITNESS	
TYPED/PRINTED NAME		TYPED/PRINTED NAME	
ADDRESS: _____		ADDRESS: _____	
Signature	Date	Signature	Date

**INFORMATION PROTECTED BY PRIVACY  
 ACT OF 1974**

Authority 10 U.S.C. 8012, Secretary of the Air Force; powers and duties; delegation by; implemented by DOI 12-1, Office Locator.

Purpose is to request consent for participation in approved medical research studies. Disclosure is voluntary

Routine Use Information may be disclosed for any of the blanket routine uses published by the Air Force and reprinted in AFP 12-36 and in Federal Register 52 FR 16431.



## INFORMED CONSENT DOCUMENT

74TH MEDICAL GROUP  
Wright-Patterson Medical Center  
4881 Sugar Maple Drive  
Wright-Patterson AFB OH 45433-5529

Privacy Act of 1974 applies. DD Form 2005 filed in Clinical/Medical Records.

**PRIVACY ISSUES:** Records of my participation in this study may only be disclosed in accordance with federal law, including the Federal Privacy Act, 5 USC 552a, and its implementing regulations. DD Form 2005 contains the Privacy Act Statement for the records. I understand that records of this study may be inspected by the U.S. Food and Drug Administration (FDA), the sponsoring agency and/or their designee, if applicable.

### TITLE OF STUDY

PROTOCOL 83-30  
(Version 1.2104 October 96)  
ACCOMMODATION AND OCCUPATIONAL SAFETY FOR PREGNANT MILITARY PERSONNEL

### INVESTIGATORS' NAMES, DEPARTMENTS, PHONE NUMBERS

Kathleen M. Robinette, AL/CFHD, (513) 255-8810  
Barbara McQuiston, Sytronics, Inc., (513) 429-1466 (Ext. 106)  
Teresa Crase, Sytronics, Inc., (513) 255-0865  
Sherri Blackwell, Sytronics, Inc., (513) 255-0861  
Dennis Burnside, Sytronics, Inc., (513) 255-0864  
Col Kathleen McCauley, OB/GYN, (513) 257-1967  
Sarah Caudill, OB/GYN, (513) 257-1952

### PURPOSE OF STUDY

(This section will explain the nature, purpose(s), approximate number of subjects, and the duration of participants' involvement.)

I, \_\_\_\_\_, SSN \_\_\_\_\_, have been invited to participate in an experiment during which a number of dimensions will be measured on my body. The objectives of this study are 1) to characterize size and shape changes for a sample population of 25 pregnant women, and 2) provide recommendations for future research that evaluates the occupational constraints placed on pregnant women due to their changing body size and capabilities.

### PROCEDURES

(This section will explain all procedures and the purpose of the procedures to be undergone as part of this study. Any experimental procedures will be explained as such.)

If I decide to participate, I understand that these measurements will be used to describe the lengths, breadths, depths, circumferences, and surface contours of my body and its major segments. To aid in this process, measuring marks will be placed on my body with a water-soluble colored pencil and/or gummed-back stickers; however, these marks will be removed after measuring is completed. I also understand that the measurements may be made with several traditional advanced measuring tools. The traditional tools are an anthropometer (which is similar to a yard stick), tape measures, and various types of calipers (e.g., beam and spreading calipers). The advanced tools include digital head and whole body scanning systems which project a line of light from low-

INFORMED CONSENT DOCUMENT FOR SSG#

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(Procedures continued)

powered lasers onto the surface of my skin. This light will be digitally recorded by a video camera as the camera/laser assemblies rotate horizontally or translate vertically around me while I am measured with the head or whole body scanner, respectively. Participation in this study is restricted to currently pregnant females between the ages of 18-40 years of age. No costs will be incurred by me for participation in this study.

#### BENEFITS

This study will collect anthropometry for pregnant military personnel. These data can benefit the military by being used to evaluate policies and duty assignments for pregnant service women. This is especially important since body size and reach constraints during the latter pregnancy stages could adversely affect occupational performance and safety. I understand that I will not receive a direct benefit from participating in this study.

#### ALTERNATIVES

(This section will explain your alternative treatment possibilities)

I understand that the alternative to participating in this study is to not participate in this study.

#### RISKS/INCONVENIENCES

(Any discomfort, risks, inconveniences caused from procedures or drugs used that may be expected from participation in this study)

I understand that one portion of the traditional anthropometric data collection requires approximately 30 minutes of standing in a single position. There will be one required break (the subject is instructed to sit) approximately 15 minutes after this position is assumed. I will be instructed to request additional breaks, as my comfort and physical condition warrant. At the investigator's discretion, I may be instructed to take additional breaks.

After discussing my participation in this study with study investigators, I understand that many thousands of men and women have already been measured using the digital head scanning system with no adverse effects. I further understand that hundreds of men and women have been measured using the whole body scanning system with no adverse effects and that there have been no adverse effects or safety issues with repeated scans of subjects.

#### EVENT OF INJURY

I understand that my entitlement to medical and dental care and/or compensation in the event of injury is governed by federal laws and regulations, and if I have questions about my rights or if I believe I have received a research-related injury, I may contact the Chief of the Medical Staff at (513) 257-9129, the Director of Clinical Investigations at (513) 257-9024, and/or the investigator, \_\_\_\_\_ at \_\_\_\_\_.

#### OCCURRENCE OF UNANTICIPATED EVENT

If an unanticipated event (clinical or medical misadventure) occurs during my participation in this study, I will be informed. If I am not competent at the time to understand the nature of the event, such information will be brought to the attention of my guardian or next of kin.

# DECISION TO PARTICIPATE

The decision to participate in this study is completely voluntary on my part. No one has coerced or intimidated me into participating in this program. I am participating because I want to. My investigator(s) has/have adequately answered any and all questions I have about this study, my participation, and the procedures involved. I understand that the investigator will be available to answer any questions concerning procedures throughout this study. I understand that if significant new findings develop during the course of this study that may relate to my decision to continue participation, I will be informed. I further understand that I may withdraw this consent at any time and discontinue further participation in this study without prejudice to my entitlement to care. I also understand that the investigator of this study may terminate my participation in this study at any time if he/she feels this to be in my best interest. My confidentiality as a participant in this program will be protected. Specifically, this means that my name and Social Security Number will not be stored with or connected with my data. I understand that it may be possible to recognize me from the data collected with the head and whole body scanners, since these data are essentially a digital photograph. Also, I understand that all human body measurement data collected on me, including die scanned data, may be released to the public. I give my consent to release this information. Again, this release will be done without including my name or Social Security Number. I realize that once the data are released, they may be used for purposes other than those Armstrong Laboratory intended. I understand that during my participation in this study I may be photographed, filmed, or audio/video taped. I consent to the use of these media for research and training purposes and understand that any release of records of my participation in this study may only be disclosed according to federal law, including the Federal Privacy Act, 5 U.S.C. 552a, and its implementing regulations. This means personal information will not be released to an unauthorized source without my permission. I have been provided a copy of this consent form.

My signature below indicates my willingness to participate in this research study

_____ (Subject's Printed Name)		_____ (Subject's SSN)
_____ (Subject's Signature)	_____ (FMP & Sponsor's SSN)	_____ (Date)
_____ (Father's Signature)	_____ (Father's SSN)	_____ (Date)
_____ (Advising Investigator's Signature)	_____ (Investigator's SSN)	_____ (Date)
_____ (Witness's Signature)	_____ (Witness's SSN)	_____ (Date)

## **Appendix G: Questionnaire Responses**

## PREGNANT WOMEN'S STUDY QUESTIONNAIRE RESPONSES

In the following tables, an entry of "N/A" means the question did not apply to the respondent. An entry of "N/R" means the subject did not provide a response to that question. In some places additional questions are asked based on a "Yes" response to a previous question, for those questions only responses from those subjects to whom the additional questions apply are provided.

**TABLE G-1. Personal Data.**

Subject #	Race of Baby's Mother	Race of Baby's Father	Race of Baby	Due date
2	White	White	White	22 Sep 97
3	Black	White	Other	27 Aug 97
4	White	White	White	7 Jul 97
5	White	White	White	15 Aug 97
6	White	White	White	7 Aug 97
7	White	White	White	26 Aug 97
8	White	White	White	6 Sep 97
10	White	White	White	25 Aug 97
11	White	White	White	6 Sep 97
12	White	White	White	10 Aug 97
13	White	White	White	6 Aug 97
15	Hispanic	White/Black	Other	21 Sep 97
16	White	White	White	15 Sep 97
17	White	White	White	30 Sep 97
18	White	White	White	27 Aug 97
19	White	White	White	8 Oct 97
20	Hispanic	White	Other	29 Sep 97
21	White	White	White	22 Sep 97
22	White	White	White	21 Oct 97
24	White	White	White	29 Oct 97
27	White	White	White	16 Oct 97
28	White	White	White	5 Nov 97
30	White	White / Hispanic / American Indian or Alaska Native	Other	10 Dec 97
32	White	White	White	14 Nov 97
33	White	White	White	23 Nov 97

Subject #	Number of previous live births?	Number of pregnancies (including this one)?	Do you smoke?	Has this changed since you became pregnant?
2	0	1	No	No
3	1	2	No	No
4	0	1	No	No
5	0	1	No	No
6	0	1	No	No
7	0	1	No	No
8	0	1	No	No
10	0	1	No	No
11	0	1	No	No
12	1	3	No	No
13	2	4	No	No
15	1	2	No	No
16	0	1	No	No
17	0	1	No	No
18	0	1	No	No
19	0	1	No	No
20	2	4	No	No
21	1	2	No	No
22	2	3	No	No
24	0	2	No	No
27	0	1	No	No
28	0	1	No	No
30	0	1	No	No
32	0	1	No	No
33	1	2	No	No

**TABLE G-2. Occupation.**

Subject #	Military Status (AFSC)	Job Title
2	Civilian	Unemployed
3	Civilian	Secretary - Office Automation
4	Civilian	Psychology Research Assoc.
5	Air Force, AFSC: N/R	N/R
6	Civilian	Registrar
7	Air Force, AFSC: 4NO71	Superintendent OB/GYN Flight
8	Air Force, AFSC: O62E3E	Space Mission Control Engineer
10	Civilian	Physical Therapist
11	Civilian	Unemployed
12	Air Force, AFSC: 4TO51	Research Laboratory Technician
13	Civilian	Unemployed
15	Civilian	Sales Clerk
16	Air Force, AFSC: 63A3	F-16 Engine Program Manager
17	Civilian	Teacher
18	Air Force, AFSC: 51J3	Assistant Staff Judge Advocate
19	Civilian	Teacher
20	Civilian	Unemployed
21	Air Force, AFSC: 46N3	RN (nurse)
22	Civilian	Unemployed
24	Civilian	Unemployed
27	Civilian	Student
28	U.S. Navy Hospital Corpsman (0000)	Research Technician
30	Air Force, AFSC: 3PO52	Law Enforcement Specialist
32	Civilian	Teacher
33	Civilian	Unemployed

Subject #	Is your job a desk or non-desk job?	How many hours do you work per day?	How many hours do you work per week?	Do you stand, sit, or both stand and sit on the job?
2	N/A	N/A	N/A	N/A
3	Desk	8	40	Both
4	Desk	8	40	Sit
5	N/R	8	40	N/R
6	Desk	7.5	37.5	Both
7	Desk	9 to 10	40 to 45	Both
8	Desk	8	40	Both
10	Non-Desk	8	40	Stand
11	N/A	N/A	N/A	N/A
12	Both	8	40	Both
13	N/A	N/A	N/A	N/A
15	Non-Desk	3 to 10	15 to 40	Both
16	Desk	9	45	Sit
17	Non-Desk	2 to 3	10 to 13	Both
18	Desk	8 to 10	40 to 50	Both
19	Non-Desk	7	35	Both
20	N/A	N/A	N/A	N/A
21	Non-Desk	12.5	38 to 50	Stand
22	N/A	N/A	N/A	N/A
24	N/A	N/A	N/A	N/A
27	Non-Desk	8	40	Both
28	Both	8.5	40	Both
30	Desk	8 to 11	40 to 60	Both
32	Non-Desk	8.5	43	Both
33	N/A	N/A	N/A	N/A



**TABLE G-2A. Standing.**

Subject #	Please describe your work area.
2	N/A
3	I work in an office which handles mostly paper. Area of 8' x 12'. Book shelves, file cabinet, supply cabinet, typewriter, desk, computer work station (not adjustable). Periodically move around room to answer phone, distribute mail, speak with supervisors.
4	N/A
5	N/R
6	I work in an historic home and museum. During the day I am up and down stairs moving to other parts of the building. The times during which I am standing primarily all day would be during inventory or an exhibition. My tasks during exhibitions involve making condition reports of objects. In order to examine these objects, sometimes I must stand, crouch, kneel, or bend over for a good portion of the day.
7	I oversee 34 medical technicians in the OB/GYN department. All departments are located on the same floor as my office. I walk and check on each department 1-2 times per day. My other duties require I go to various offices in the medical center - 6 floors, I usually take the stairs.
8	Walk to other parts of the building.
10	I work for 2 hospitals. In one I work in a satellite clinic -- patients come to see me. Our rehabilitation room is approximately 200' x 75'. Patient booths, where I often am one-on-one with a patient, are approximately 15' x 10'. I also work in a hospital sometimes seeing inpatients which means walking floor-to-floor. I also see outpatients who come to the clinic. This clinic is larger -- about 2 to 3 times larger. I stand most of my day and walk a great deal. Treatment tables are height adjustable.
11	N/A
12	I work in a lab where I perform surgery on rats and stand while doing this. The procedure is once a week for about 2 hours, the Table Ls about waist high to me. I stand at the lab bench on and off. The lab bench is just above waist high to me.
13	N/A
15	I work in a store where I dust, clean, straighten up things that are placed wrong on the shelves, and fix dresses that customers put away wrong. Other times I sit to do jewelry on a machine, then I put data on computer. In my job I also have to speak two languages for customers who come to the store and on the phone.
16	N/A
17	I work in an elementary school. I can be found in the second floor gymnasium most of the time. The gym is small (a little larger than a full sized basketball court). I am on my feet walking around 90% of the time. I sometimes sit on a bench to watch the kids play. I am usually moving.
18	I work in the courtroom on base.
19	I work in an average size classroom.
20	N/A
21	I work in a nursery with radiant warmers, isolettes and cribs. I write on bedside tables that are adjustable
22	N/A
24	N/A
27	I work in a horse barn. The barn is about the size of a football field. We keep about 15 horses in the barn. The stalls are about 16 feet square.

Subject #	Please describe your work area.
28	I work in a research laboratory that requires me to get up and move around as I collect data. The room is approximately 12' wide by 16' long. Operant boxes are mounted on the far wall at about upper torso/head high. The computer is located under the boxes on a portable table. I walk across the hallway to get the subjects for the boxes.
30	N/R
32	I am a teacher, so I am constantly moving around the classroom to help the students. I have two adjustable tables, but my desk and chair are not adjustable. I am the farthest room from everything that goes on, so I am always walking.
33	N/A

Subject #	How many hours per day do you actually stand? OR, what percentage (%) of the time do you stand while you work?	How long do you work in a standing position at one time?
2	N/A	N/A
3	1 to 3 hours	5 to 15 minutes
4	N/A	N/A
5	N/R	N/R
6	2 to 6 hours	10 minutes to 6 hours
7	2 to 3 hours	0
8	3 hours	10 to 15 minutes
10	90%	2 hours
11	N/A	N/A
12	2 to 3 hours	5 to 30 minutes
13	N/A	N/A
15	48%	2 hours (varies)
16	N/A	N/A
17	2.5 to 3 hours, 90%	1 hour
18	10% (varies)	15 minutes
19	5%	5 minutes
20	N/A	N/A
21	10 to 12 hours	hours
22	N/A	N/A
24	N/A	N/A
27	5 hours	2 to 3 hours
28	5 hours, 60%	30 to 60 minutes
30	N/R	N/R
32	80%	45 minutes
33	N/A	N/A

Subject #	Do you operate machinery while you are standing?	Please explain in detail what type of machine you work with or operate.
2	N/A	
3	Yes	Printer
4	N/A	
5	N/R	
6	Yes	Fax machine, copier, mail sorter
7	No	
8	No	
10	Yes	Exercise machines: pulley system, free weights, nautilus machines, balance machines, plyometric machines Modality machines: ultrasound, electric stimulation
11	N/A	
12	No	
13	N/A	
15	No	
16	N/A	
17	No	
18	No	
19	No	
20	N/A	
21	Yes	Monitors, B/P machines, IV pumps, ventilators, isolettes, radiant warmers
22	N/A	
24	N/A	
27	Yes	I sometimes drive a tractor
28	No	
30	N/R	
32	No	
33	N/A	

Subject #	While standing, do you lift any type of objects(s)?	Approximately how much do the objects weigh?	What size are the objects?	How often do you lift the object(s)?
2	N/A			
3	Yes	Less than a pound	8" x 11" file folders	Once a week
4	N/A			
5	N/R			
6	Yes	1 ounce to 10 pounds	2" - 24" high	5 to 10 times per hour during exhibitions
7	No			
8	No			
10	Yes	1 pound to 70 pounds	From small ankle weights to people	Weights: about 5 times per hour. People (or parts of them): about 3 times per hour
11	N/A			
12	Yes	Ounces	Small	Often
13	N/A			
15	Yes	5 pounds to 10 pounds	Varies	Once or twice only
16	N/A			
17	Yes	1 pound	Small (playground balls, etc.)	5 to 10 times per hour
18	No			
19	No			
20	N/A			
21	Yes	7 pounds to 10 pounds	Babies, linen, medicines, medical supplies	N/R
22	N/A			
24	N/A			
27	Yes	25 pounds to 50 pounds	2' x 3'	5 to 8 times per day
28	Yes	400 grams to 20 pounds	Pigeons and notebook paper size objects	Pigeons: 2 to 5 times per hour. Other: 1 to 2 times per hour
30	Yes	50 pounds	Paper box	1 to 2 times per month
32	No			
33	N/A			

**TABLE G-2B. Sitting.**

Subject #	Please describe your work area.
2	N/A
3	I work in a 8' x 12' room with one desk and one computer station; two offices off to the side. The chairs I use are adjustable.
4	I work in a large hallway with a small cubicle at one side. My office (the cubicle) is approximately 6' x 8'. The desk is not adjustable. The chair is height adjustable.
5	N/R
6	I work in an office which I share with two other people. The room is approximately 15' x 20'. My desk is about 3' high and contains a computer with a monitor that is at an angle and a keyboard which is too high. While my chair is adjustable for height, my desk is not. Periodically, I move to other parts of the office to use filing cabinets and bookshelves.
7	I work in a two person office. I work at my desk and at a computer. The chair in which I sit adjusts in height and angle. I also attend 3 to 4 meetings per week with various style chairs in the conference room.
8	I sit at a desk with an adjustable chair and work on a computer most of the day.
10	N/A
11	N/A
12	I sit at lab hoods and lab benches pipetting and preparing samples for analysis
13	N/A
15	I sit to do jewelry on a machine, then I put data on computer.
16	I work in a medium sized room with 10 desks lined along the wall. Each work area is divided by partitions. The cubes are approximately 7' x 7'. The chair in which I sit adjusts in both height and sitting angle.
17	I sit on a bench in a small gymnasium.
18	I sit at a desk. My chair is adjustable and I have a foot stool under my desk that is adjustable. My office is about 8' x 8'. My computer is directly behind me and the keyboard is on an adjustable table.
19	I work in an average size classroom. There aren't any desks, just 3 tables and chairs. I sit in a regular plastic office seat 50% of the time and small plastic children's seat the other 50%. So I sit in all different areas of the room. I also sit on the carpet once in a while.
20	N/A
21	N/A
22	N/A
24	N/A
27	I sit in an average size classroom. I sit in a student chair that does not adjust.
28	I work in a small office with two other people. We each have a desk and the room is approximately 10' x 20'. The chair in which I sit adjusts in height as well as in angle. I have wrist pads for both the keyboard and mouse. The desk is not adjustable.
30	I work in a huge room which has a number of desks lined up in rows. There are lower partitions between my desk and my supervisor's desk. The cubes are small, larger than 8' x 6'. The chair in which I sit adjusts in height.
32	Since I am a teacher, I have many obstacles to watch out for in my room: the desks, tables, children, bookbags, and coats. My two tables I use are adjustable, but my desk and chair are not.
33	N/A

Subject #	How many hours per day do you actually sit? OR, what percentage (%) of the time do you sit while you work?	How long do you work in a sitting position at one time?
2	N/A	N/A
3	5 to 6 hours	1 to 2 hours
4	7 hours	1 hour
5	N/R	N/R
6	6 hours	1 hour
7	4 to 5 hours	30 minutes to several hours
8	5 hours	2 to 3 hours
10	N/A	N/A
11	N/A	N/A
12	6 to 8 hours, 85%	30 minutes to 2 hours
13	N/A	N/A
15	55%	2 to 3 hours
16	8 hours	30 minutes to 1 hour
17	15 minutes, 10%	2 to 5 minutes
18	varies, 75%	1 hour
19	95%	5 to 30 minutes
20	N/A	N/A
21	N/A	N/A
22	N/A	N/A
24	N/A	N/A
27	2 to 3 hours	1 to 1.5 hours
28	3.5 hours, 40%	1 hour
30	90%	1 hour
32	20%	10 minutes
33	N/A	N/A

Subject #	Do you operate machinery while you are sitting?	Please explain in detail what type of machine or device you work with or operate.
2	N/A	
3	Yes	Computer equipment, printers, typewriters
4	Yes	Computer
5	N/R	
6	Yes	Computer, typewriter, telephone
7	No	
8	Yes	Computer
10	N/A	

Subject #	Do you operate machinery while you are sitting?	Please explain in detail what type of machine or device you work with or operate.
11	N/A	
12	No	
13	N/A	
15	Yes	The machinery is called a linker. The linker is a type of machine to make jewelry.
16	Yes	I work with a computer that has 14" screen. The monitor angle can be adjusted for better viewing. The keyboard is waist high and can be adjusted.
17	No	
18	No	
19	No	
20	N/A	
21	N/A	
22	N/A	
24	N/A	
27	No	
28	Yes	Computer
30	Yes	Computer, typewriter
32	No	
33	N/A	

Subject #	While sitting, do you lift any type of object(s)?	Approximately how much do the objects weigh?	What size are the object(s)?	How often do you lift the object(s)?
2	N/A			
3	Yes	Less than a pound	Paper size (8.5" x 11")	1 to 2 times an hour
4	No			
5	N/R			
6	Yes	1 ounce to 5 pounds	1" - 14"	30 times per hour
7	No			
8	No			
10	N/A			
11	N/A			
12	Yes	Light (ounces)	Small	Often
13	N/A			
15	No			
16	No			
17	No			
18	No			

Subject #	While sitting, do you lift any type of object(s)?	Approximately how much do the objects weigh?	What size are the object(s)?	How often do you lift the object(s)?
19	No			
20	N/A			
21	N/A			
22	N/A			
24	N/A			
27	No			
28	Yes	2 pounds to 5 pounds	Notebook paper size	5 to 10 times per hour
30	Yes	1 pound to 2 pounds	Paper size	2 times per day
32	No			
33	N/A			



**TABLE G-3. General Reach Data.**

Subject #	During the work day, do you ever have difficulty reaching for an object or objects with one arm?	If YES, how far do you think you reach?	Do the object(s) you reach for have good handles, grips, etc.?	Which direction(s) do you typically reach (up, to the left, etc.)?
2	N/A		N/A	N/A
3	No	6'	Not always	Up both ways
4	No		N/A	N/A
5	N/R		N/R	N/R
6	Yes	2' to 3'	Yes	In all directions
7	No		N/A	N/A
8	No		N/A	N/A
10	No		Yes	In front of me; stomach, shoulder or chest height
11	N/A		N/A	N/A
12	No		Yes	Forward, right and left
13	N/A		N/A	N/A
15	Yes	I can reach until my stomach doesn't let me.	Sometimes	Varies
16	Yes	5'	No	Up to the right (I stand to get notebook binders instead of sitting.)
17	No		N/A	N/A
18	No		N/A	N/A
19	No		N/A	N/A
20	N/A		N/A	N/A
21	No		N/R	Up, down, left, right
22	N/A		N/A	N/A
24	N/A		N/A	N/A
27	No		N/A	N/A
28	No		N/A	N/A
30	No		N/A	N/A
32	Yes	A few (no more than 2) feet	Not particularly	Left or right
33	N/A		N/A	N/A

Subject #	During the work day, do you ever have difficulty reaching for an object or objects with both arms?	If YES, how far do you think you reach?	Do the object(s) you reach for have good handles, grips, etc.?	Which direction(s) do you typically reach (up, to the left, etc.)?
2	N/A		N/A	N/A
3	No	6'	Not always	Up both ways
4	No		N/A	N/A
5	N/R		N/R	N/R
6	Yes	3'	Yes	All directions
7	No		N/A	N/A
8	No		N/A	N/A
10	No		Yes	Front; shoulder, stomach or chest height
11	N/A		N/A	N/A
12	No		Yes	Forward, right and left
13	N/A		N/A	N/A
15	Yes	I can reach until my stomach doesn't let me	Sometimes	Varies
16	No		N/A	N/A
17	No		N/A	N/A
18	No		N/A	N/A
19	No		N/A	N/A
20	N/A		N/A	N/A
21	No		N/R	Up, down, right and left
22	N/A		N/A	N/A
24	N/A		N/A	N/A
27	No		N/A	N/A
28	No		N/A	N/A
30	No		N/A	N/A
32	No		N/A	N/A
33	N/A		N/A	N/A

Subject #	Do you perform any typing tasks?	Is there a wrist pad in front of the keyboard?	How many hours of the working day do you spend typing?
2	N/A		
3	Yes	Yes	0 to 4 hours
4	Yes	No	7 hours
5	N/R		
6	Yes	No	2 to 4 hours
7	Yes	No	2 to 3 hours
8	Yes	Yes	2 to 3 hours

Subject #	Do you perform any typing tasks?	Is there a wrist pad in front of the keyboard?	How many hours of the working day do you spend typing?
10	No		
11	N/A		
12	Yes	Yes	1 hour
13	N/A		
15	Yes	No	Varies
16	Yes	No	5 hours
17	No		
18	Yes	Yes	N/R
19	No		
20	N/A		
21	Yes	No	30 minutes
22	N/A		
24	N/A		
27	No		
28	Yes	Yes	1 to 2 hours
30	Yes	No	4 to 6 hours
32	Yes	No	30 minutes
33	N/A		

Subject #	Do you take breaks?	How often do you take breaks?	How long does each break last?
2	N/A		
3	Yes	Every hour	5 to 10 minutes
4	Yes	Every hour	5 minutes
5	N/R		
6	Yes	Once per day	15 minutes
7	Yes	1 to 2 times per day	10 to 15 minutes
8	Yes	Every hour	10 minutes
10	No		
11	N/A		
12	Yes	2 to 3 per day	15 to 30 minutes
13	N/A		
15	Yes	Whenever I can take it	10 to 20 minutes
16	Yes	About once every 1.5 hours	5 to 10 minutes
17	No		
18	Yes	Every 30 minutes to 1 hour	5 to 10 minutes
19	No		
20	N/A		
21	No		
22	N/A		
24	N/A		
27	Yes	Every 1 to 1.5 hours	10 to 15 minutes

Subject #	Do you take breaks?	How often do you take breaks?	How long does each break last?
28	Yes	Every 2 to 3 hours	10 to 15 minutes
30	Yes	When needed	5 to 15 minutes
32	Yes	Once or twice a day	15 minutes; 30 to 35 minutes
33	N/A		

Subject #	Do you break for a lunch?	How long?
2	N/A	
3	Yes	30 minutes to 1 hour
4	Yes	30 minutes to 1 hour
5	N/R	
6	Yes	30 minutes
7	Yes	30 minutes to 1 hour
8	Yes	30 minutes
10	Yes	30 minutes (sitting doing paperwork)
11	N/A	
12	Yes	1 hour
13	N/A	
15	Yes	20 to 30 minutes (varies)
16	No, I eat at my desk while working	
17	No, I usually work after lunch	
18	Yes	30 minutes to 1 hour
19	Yes	45 minutes
20	N/A	
21	Yes	20 minutes
22	N/A	
24	N/A	
27	Yes	1 hour
28	Yes	30 minutes
30	Yes	20 to 30 minutes
32	Yes	45 minutes (unless I have duty -- 25 minutes)
33	N/A	

**TABLE G-4. Potential Difficulties.**

Subject #	Considering your work environment, do you foresee pregnancy hindering or limiting your job performance in any way? Please explain your answer.
2	N/A
3	N/R
4	No. I will need to use the restroom more often, but my work shouldn't be affected.
5	N/R
6	Yes. The normal, everyday tasks I am responsible for would not be hindered. However, on occasion, I am asked to travel as a courier for a work of art. In later months it would be difficult for me to travel with a hand-carry case along with luggage. Also, I would not be able to take any long truck trips with art work.
7	No
8	No
10	Yes. Due to amount of mobility required of me on the job, I could foresee problems as I get bigger. But, I also am fortunate as I can adapt my job - sit on a stool more, pass patients that require a lot of assistance and shorten my work day.
11	N/A
12	No
13	N/A
15	Yes. I believe that when I reach my 7th or 8th month my stomach will be in the way in order to do most of my performance at my job. I am going to leave my job eventually before the baby will be born.
16	No. I think my work environment can be adjusted to meet my changing needs as the pregnancy progresses. For example, the chair height/angle, monitor and keyboard placement, location of binders and phone can all be adjusted for better access/use. I also feel I take adequate breaks to prevent backaches, headaches. etc.
17	Yes. I do a lot of moving to keep up with elementary school age children. I clean up the play area often. I do a lot of bending over.
18	No
19	No. I don't lift the children or any other objects and I'm not restricted by a desk.
20	N/A
21	Yes. May slow me down.
22	N/A
24	N/A
27	Yes. Working with horses is very hard work. As the pregnancy advances it will be hard to keep up with the work.
28	No
30	Yes. Unable to work several flight Law Enforcement Positions during exercises due to physical profile.
32	No. I do not see pregnancy hindering my performance at all. I will probably try to sit down a lot more, especially when I am 7 to 8 months pregnant. I work with very wonderful people who are always willing to help out.
33	N/A

Subject #	In your opinion, does your boss or supervisor feel that pregnancy will affect your job performance in any way? Please explain your answer.
2	N/A
3	N/R
4	No, my research project does not have a firm completion date so my maternity leave will not be a problem.
5	N/R
6	No, my supervisor is very understanding and accommodating and is even willing to allow me to work at home if I want to during my maternity leave.
7	No, since I work in the OB/GYN dept my supervisor understands the changes a pregnant woman goes through. My supervisor and others in authority positions are very supportive and understanding.
8	No
10	No, both supervisors feel that I will not have any problems. I have spoken with them and they know that if it becomes too much to handle then I can cut back my hours. Many therapists work up until 0-2 weeks before they are due. I have good co-workers, too, so if I need assistance I could always ask for help.
11	N/A
12	No
13	N/A
15	Yes, I won't be able to perform or do the things I used to do.
16	No, due to the pregnancy, my number of TDYs will be reduced, but this won't affect my ability to get the job done or my performance.
17	N/R
18	No
19	No
20	N/A
21	No
22	N/A
24	N/A
27	Yes, only because of the heavy lifting that has to be done.
28	No, there was a question by my supervisor about that in the beginning because my job involves working with controlled drugs and experimental drugs.
30	No, office job unaffected.
32	No, I have already talked to my boss (and her boss) about this and it will in no way affect my position or my job performance.
33	N/A

Subject #	List other tasks which you feel will be more difficult for you to perform during your pregnancy.
2	N/R
3	N/R
4	Cleaning the house, laundry, putting on clothes, tying shoes, standing up in the tub, carrying things (groceries)
5	N/R
6	N/R
7	N/R
8	N/R
10	Getting in and out of small, low cars, getting in and out of tub, tying my shoes, taking big dog for a walk - he likes to pull on leash, shaving my legs, unloading the dishwasher
11	N/R
12	N/R
13	N/R
15	Lifting and standing for a long period of time
16	I can't think of any now. When I get farther along, I might change my mind due to my expanded waist and/or difficulty in getting up and moving around.
17	N/R
18	N/R
19	N/R
20	N/R
21	N/R
22	Scrubbing the floor, shaving my legs, sleeping on stomach, standing for long periods of time
24	N/R
27	N/R
28	Bending down to remove pigeons from their home cages. Reaching up high to remove pigeons from their home cages.
30	Tie shoes, walk long distances, sleep
32	Driving - I own a manual drive Honda Accord. I don't know if I'll be able to reach the clutch at 8-9 months.
33	N/R

## **Appendix H: Summary Statistics for Linear Measurements**



**Table H-1. Weeks of Pregnancy for Each Session.**

Session	N	Weeks of Pregnancy			
		Mean	Standard Deviation	Minimum	Maximum
1	25	9.1	2.8	4	16
2	25	20.8	1.4	18	24
3	22	28.4	0.9	27	31
4	21	32.4	0.8	31	35
5	17	37.3	0.6	37	39
6	18	3.7	1.7	2	8.5

**Table H-2. Summary Statistics for Subjects who Completed the Baseline Session  
and at Least One Additional Session.**

(Weight is in lbs., all others in cm)

Measurement Name	Session	N	Mean	Standard Deviation	Minimum	Maximum
Abdominal Ext. Depth, Sitting	1	25	22.71	3.11	16.60	28.60
Abdominal Ext. Depth, Sitting	2	25	26.61	3.21	21.40	32.00
Abdominal Ext. Depth, Sitting	3	22	29.92	2.61	25.50	35.00
Abdominal Ext. Depth, Sitting	4	21	31.34	2.53	26.00	36.40
Abdominal Ext. Depth, Sitting	5	17	33.22	2.79	28.20	38.60
Abdominal Ext. Depth, Sitting	6	18	25.07	3.13	19.20	31.50
Ankle Circumference	1	25	21.18	1.06	19.10	23.10
Ankle Circumference	2	25	21.28	1.24	18.90	24.30
Ankle Circumference	3	22	21.50	1.23	19.00	23.50
Ankle Circumference	4	21	21.52	1.31	18.90	23.90
Ankle Circumference	5	17	22.14	1.67	19.00	25.60
Ankle Circumference	6	18	20.94	1.26	18.50	22.80
Buttock-Knee Length	1	25	57.90	2.41	52.60	61.60
Buttock-Knee Length	2	25	58.13	2.41	52.40	62.30
Buttock-Knee Length	3	22	59.02	2.27	52.90	62.40
Buttock-Knee Length	4	21	59.10	2.36	53.30	62.30
Buttock-Knee Length	5	17	59.54	2.12	54.40	62.80
Buttock-Knee Length	6	18	58.68	1.92	54.50	61.30
Calf Circumference	1	25	35.82	2.61	31.70	41.00
Calf Circumference	2	25	36.15	2.71	31.50	42.00
Calf Circumference	3	22	37.03	2.84	32.30	42.10
Calf Circumference	4	21	37.01	2.90	32.70	42.30
Calf Circumference	5	17	37.70	3.12	33.20	43.10
Calf Circumference	6	18	35.60	2.90	31.10	40.90
Cervicale Height, Sitting	1	25	64.25	2.34	59.00	68.90
Cervicale Height, Sitting	2	25	64.47	2.14	59.80	69.00
Cervicale Height, Sitting	3	22	64.34	2.21	59.80	69.10
Cervicale Height, Sitting	4	21	64.25	2.20	59.70	67.40
Cervicale Height, Sitting	5	17	64.32	2.40	59.50	68.30
Cervicale Height, Sitting	6	18	63.77	2.08	59.50	66.70
Cervicale Height	1	25	141.68	4.79	133.90	150.30
Cervicale Height	2	25	141.56	4.66	133.90	149.40
Cervicale Height	3	22	141.60	4.80	132.80	149.90
Cervicale Height	4	21	141.58	4.99	132.80	149.70
Cervicale Height	5	17	141.98	4.44	134.30	148.80
Cervicale Height	6	18	141.43	4.34	133.60	149.50

**Summary Statistics for Subjects who Completed the Baseline Session and at Least One Additional Session**

Measurement Name	Session	N	Mean	Standard Deviation	Minimum	Maximum
Chest Breadth	1	25	28.47	1.90	25.60	31.60
Chest Breadth	2	25	29.49	2.20	26.20	34.00
Chest Breadth	3	22	30.43	2.03	27.00	34.20
Chest Breadth	4	21	30.76	2.08	27.20	35.50
Chest Breadth	5	17	31.01	2.30	27.20	34.80
Chest Breadth	6	18	29.58	2.34	26.20	33.90
Chest Breadth Below Bust	1	25	26.71	1.54	23.80	29.50
Chest Breadth Below Bust	2	25	27.17	1.65	23.50	30.10
Chest Breadth Below Bust	3	22	27.87	1.58	24.50	30.30
Chest Breadth Below Bust	4	21	28.03	1.45	24.80	30.60
Chest Breadth Below Bust	5	17	28.46	1.52	24.80	30.70
Chest Breadth Below Bust	6	18	26.71	1.56	23.80	29.60
Chest Circumference	1	25	89.21	6.61	79.90	101.50
Chest Circumference	2	25	92.69	6.47	83.70	108.40
Chest Circumference	3	22	95.86	7.62	85.00	113.80
Chest Circumference	4	21	96.59	7.10	85.10	113.30
Chest Circumference	5	17	98.86	8.02	87.50	114.10
Chest Circumference	6	18	95.08	7.42	83.20	109.60
Chest Circumference Below Bust	1	25	76.51	4.75	66.00	83.90
Chest Circumference Below Bust	2	25	79.07	4.38	70.80	89.50
Chest Circumference Below Bust	3	22	81.70	4.74	74.20	91.80
Chest Circumference Below Bust	4	21	82.20	4.36	75.20	93.00
Chest Circumference Below Bust	5	17	84.42	4.76	76.80	92.90
Chest Circumference Below Bust	6	18	77.94	4.20	71.50	85.00
Chest Depth	1	25	23.08	2.19	19.20	27.90
Chest Depth	2	25	24.03	2.38	19.80	30.30
Chest Depth	3	22	24.85	2.29	21.60	29.80
Chest Depth	4	21	24.91	2.17	21.20	29.90
Chest Depth	5	17	25.23	2.39	21.40	30.20
Chest Depth	6	18	24.11	2.47	20.60	29.50
Chest Depth Below Bust	1	25	19.57	1.70	16.40	22.50
Chest Depth Below Bust	2	25	20.31	1.93	16.40	24.80
Chest Depth Below Bust	3	22	21.29	1.81	18.30	25.30
Chest Depth Below Bust	4	21	21.69	1.66	18.60	25.60
Chest Depth Below Bust	5	17	22.04	1.89	18.10	25.60
Chest Depth Below Bust	6	18	19.51	1.58	16.60	22.80

**Summary Statistics for Subjects who Completed the Baseline Session and at Least One Additional Session**

Measurement Name	Session	N	Mean	Standard Deviation	Minimum	Maximum
Chest Height	1	25	119.06	3.83	112.70	128.80
Chest Height	2	25	119.26	4.19	112.60	128.70
Chest Height	3	22	119.98	4.05	112.70	129.70
Chest Height	4	21	119.89	4.12	111.40	129.80
Chest Height	5	17	120.73	3.46	113.70	128.10
Chest Height	6	17	117.92	3.98	110.50	128.00
Chest Height Below Bust	1	25	113.91	3.59	108.00	122.50
Chest Height Below Bust	2	25	113.63	4.04	106.60	122.30
Chest Height Below Bust	3	22	114.35	3.85	106.90	123.00
Chest Height Below Bust	4	21	114.44	4.05	106.00	123.20
Chest Height Below Bust	5	17	115.23	3.40	109.00	123.10
Chest Height Below Bust	6	18	112.35	3.47	106.30	121.40
Foot Breadth	1	25	8.89	0.38	8.30	9.50
Foot Breadth	2	25	8.71	0.33	7.90	9.30
Foot Breadth	3	22	8.61	0.37	8.00	9.30
Foot Breadth	4	21	8.75	0.51	7.90	9.70
Foot Breadth	5	17	8.75	0.39	8.10	9.40
Foot Breadth	6	18	8.72	0.48	7.80	9.50
Hand Breadth	1	25	7.54	0.32	7.00	8.30
Hand Breadth	2	25	7.52	0.34	7.00	8.20
Hand Breadth	3	22	7.65	0.35	7.00	8.40
Hand Breadth	4	21	7.60	0.36	7.00	8.20
Hand Breadth	5	17	7.71	0.38	7.00	8.40
Hand Breadth	6	18	7.62	0.38	7.00	8.30
Hip Breadth	1	25	35.95	2.33	32.00	41.80
Hip Breadth	2	25	36.84	2.34	32.50	42.00
Hip Breadth	3	22	37.66	2.52	33.20	43.80
Hip Breadth	4	21	37.61	2.47	33.90	43.90
Hip Breadth	5	17	37.69	2.55	33.80	43.10
Hip Breadth	6	18	36.97	2.58	33.10	42.20
Hip Breadth, Sitting	1	25	39.17	3.00	34.60	45.70
Hip Breadth, Sitting	2	25	40.34	2.90	35.10	45.60
Hip Breadth, Sitting	3	22	41.42	2.94	36.90	47.20
Hip Breadth, Sitting	4	21	41.45	3.04	36.80	47.80
Hip Breadth, Sitting	5	17	41.67	3.09	37.10	47.50
Hip Breadth, Sitting	6	18	40.34	2.99	36.40	45.70

**Summary Statistics for Subjects who Completed the Baseline Session and at Least One Additional Session**

Measurement Name	Session	N	Mean	Standard Deviation	Minimum	Maximum
Hip Circumference	1	25	98.44	6.38	86.60	111.50
Hip Circumference	2	25	101.27	5.78	87.90	110.70
Hip Circumference	3	22	104.05	6.46	90.70	114.40
Hip Circumference	4	21	104.74	6.75	92.40	117.80
Hip Circumference	5	17	106.48	7.78	93.40	117.00
Hip Circumference	6	18	101.14	8.96	76.80	112.50
Knee Height, Sitting	1	25	50.81	1.86	46.90	54.80
Knee Height, Sitting	2	25	50.96	1.90	47.10	54.80
Knee Height, Sitting	3	22	51.40	1.80	47.80	55.10
Knee Height, Sitting	4	21	51.47	1.82	47.60	55.20
Knee Height, Sitting	5	17	51.74	1.49	49.10	55.30
Knee Height, Sitting	6	18	51.52	1.74	48.80	55.10
Patella Top Height	1	25	47.82	2.03	43.90	51.90
Patella Top Height	2	25	47.74	1.98	44.20	51.40
Patella Top Height	3	22	48.14	1.99	44.30	51.90
Patella Top Height	4	21	48.02	1.80	45.20	51.90
Patella Top Height	5	17	48.46	1.72	45.60	52.40
Patella Top Height	6	18	48.19	1.58	46.10	52.00
Sitting Height	1	25	87.87	2.74	82.10	92.60
Sitting Height	2	25	88.27	2.67	82.70	92.80
Sitting Height	3	22	88.35	2.84	81.90	92.60
Sitting Height	4	21	88.30	2.92	82.20	92.00
Sitting Height	5	17	88.16	2.91	82.20	92.10
Sitting Height	6	18	87.63	2.71	81.50	91.20
Stature	1	25	165.36	5.13	157.00	176.70
Stature	2	25	165.44	5.22	156.20	176.40
Stature	3	22	165.60	5.21	156.50	176.60
Stature	4	21	165.63	5.51	155.50	176.30
Stature	5	17	165.99	5.02	156.60	176.10
Stature	6	18	165.13	4.77	156.80	174.90
Substernale Height	1	25	117.58	3.53	110.10	127.10
Substernale Height	2	25	118.21	3.88	110.60	126.40
Substernale Height	3	22	119.30	4.26	110.00	127.00
Substernale Height	4	21	119.30	4.10	111.50	126.70
Substernale Height	5	17	119.61	3.33	113.30	124.80
Substernale Height	6	18	117.02	3.69	110.30	124.90

**Summary Statistics for Subjects who Completed the Baseline Session and at Least  
One Additional Session**

Measurement Name	Session	N	Mean	Standard Deviation	Minimum	Maximum
Suprasternale Height	1	25	134.58	4.26	127.50	143.70
Suprasternale Height	2	25	134.60	4.43	127.30	143.50
Suprasternale Height	3	22	135.01	4.61	126.60	144.30
Suprasternale Height	4	21	135.04	4.75	126.60	143.80
Suprasternale Height	5	17	135.25	4.02	127.60	143.30
Suprasternale Height	6	18	134.37	4.36	126.60	142.40
Tenth Rib Height	1	25	107.38	3.38	100.30	113.90
Tenth Rib Height	2	25	108.26	4.05	101.50	118.00
Tenth Rib Height	3	22	110.05	4.10	103.30	117.40
Tenth Rib Height	4	21	110.59	3.81	103.30	118.20
Tenth Rib Height	5	17	111.29	3.70	104.10	118.60
Tenth Rib Height	6	18	107.47	3.49	100.80	114.80
Thigh Circumference, Proximal	1	25	57.89	5.15	49.00	65.70
Thigh Circumference, Proximal	2	25	59.49	4.76	49.60	67.50
Thigh Circumference, Proximal	3	22	61.27	4.62	52.20	69.20
Thigh Circumference, Proximal	4	21	61.07	5.00	52.60	69.50
Thigh Circumference, Proximal	5	17	62.05	5.58	52.70	70.20
Thigh Circumference, Proximal	6	18	59.02	5.55	50.00	68.00
Thumbtip Reach, Right	1	25	73.88	3.63	66.20	80.30
Thumbtip Reach, Right	2	25	73.87	3.53	66.90	80.80
Thumbtip Reach, Right	3	22	74.06	3.46	67.10	82.60
Thumbtip Reach, Right	4	21	74.14	3.03	69.20	79.60
Thumbtip Reach, Right	5	17	74.13	2.76	69.10	79.30
Thumbtip Reach, Right	6	18	74.52	2.88	68.10	79.00
Weight	1	25	137.35	18.83	103.00	167.00
Weight	2	25	147.18	19.26	110.00	181.50
Weight	3	22	158.18	20.74	116.00	196.00
Weight	4	21	160.38	21.07	119.50	201.50
Weight	5	17	168.92	24.72	122.50	214.00
Weight	6	18	144.31	21.58	108.80	178.50
Waist Breadth, Omphalion	1	25	28.78	2.93	22.90	35.30
Waist Breadth, Omphalion	2	25	30.07	2.81	26.10	36.00
Waist Breadth, Omphalion	3	22	31.54	3.20	26.20	37.20
Waist Breadth, Omphalion	4	21	31.98	3.16	26.80	37.30
Waist Breadth, Omphalion	5	17	32.61	3.21	27.30	37.60
Waist Breadth, Omphalion	6	18	30.69	3.55	25.50	37.50

**Summary Statistics for Subjects who Completed the Baseline Session and at Least One Additional Session**

Measurement Name	Session	N	Mean	Standard Deviation	Minimum	Maximum
Waist Breadth, Preferred	1	25	26.25	2.05	22.00	29.80
Waist Breadth, Preferred	2	25	27.47	1.84	23.10	30.40
Waist Breadth, Preferred	3	22	28.27	1.62	25.10	30.70
Waist Breadth, Preferred	4	21	28.73	1.33	26.20	31.30
Waist Breadth, Preferred	5	17	29.32	1.47	26.80	31.80
Waist Breadth, Preferred	6	18	27.95	2.16	24.80	32.10
Waist Circumference, Omphalion	1	25	80.98	9.63	65.50	99.00
Waist Circumference, Omphalion	2	25	91.01	9.57	76.40	105.90
Waist Circumference, Omphalion	3	22	99.40	9.41	82.00	117.90
Waist Circumference, Omphalion	4	21	102.41	8.65	85.60	119.50
Waist Circumference, Omphalion	5	17	107.82	9.81	91.60	123.70
Waist Circumference, Omphalion	6	18	88.02	9.94	73.20	107.40
Waist Circumference, Preferred	1	25	75.54	6.87	64.20	87.80
Waist Circumference, Preferred	2	25	83.26	5.81	71.50	91.10
Waist Circumference, Preferred	3	22	88.27	5.31	76.80	96.80
Waist Circumference, Preferred	4	21	91.33	4.22	84.10	99.40
Waist Circumference, Preferred	5	17	95.26	4.04	88.80	101.70
Waist Circumference, Preferred	6	18	81.91	6.36	72.50	93.40
Waist Depth, Omphalion	1	25	20.72	3.26	15.70	27.30
Waist Depth, Omphalion	2	25	24.92	3.40	19.20	32.00
Waist Depth, Omphalion	3	22	28.63	3.16	23.30	36.30
Waist Depth, Omphalion	4	21	29.94	2.46	25.80	34.50
Waist Depth, Omphalion	5	17	32.72	3.13	27.60	37.80
Waist Depth, Omphalion	6	18	22.24	3.28	17.20	29.30
Waist Depth, Preferred	1	25	19.62	2.51	14.90	25.00
Waist Depth, Preferred	2	25	22.78	2.23	18.30	27.00
Waist Depth, Preferred	3	22	25.04	1.80	21.10	27.70
Waist Depth, Preferred	4	21	26.66	1.59	23.50	28.90
Waist Depth, Preferred	5	17	28.43	1.43	25.90	30.70
Waist Depth, Preferred	6	18	21.16	2.51	17.50	25.20
Waist Height, Omphalion	1	25	98.64	4.33	89.60	106.40
Waist Height, Omphalion	2	25	98.26	4.23	89.30	107.40
Waist Height, Omphalion	3	22	98.05	4.31	88.70	106.30
Waist Height, Omphalion	4	21	97.81	3.95	89.60	106.80
Waist Height, Omphalion	5	17	97.28	3.29	91.50	104.80
Waist Height, Omphalion	6	18	98.34	3.82	92.50	106.40

**Summary Statistics for Subjects who Completed the Baseline Session and at Least  
One Additional Session**

Measurement Name	Session	N	Mean	Standard Deviation	Minimum	Maximum
Waist Height, Preferred	1	25	100.93	4.33	93.60	109.00
Waist Height, Preferred	2	25	102.20	5.39	92.60	112.40
Waist Height, Preferred	3	22	104.90	7.40	87.00	116.00
Waist Height, Preferred	4	21	104.37	7.87	87.50	118.00
Waist Height, Preferred	5	17	103.56	9.31	86.80	118.60
Waist Height, Preferred	6	18	100.55	4.53	91.90	107.70



## **Appendix I: Summary Statistics for the Changes from Baseline**

**Table I-1. Summary Statistics for the Changes from Baseline for Subjects who Completed the Baseline Session and at Least One Additional Session.**

(Weight is in lbs., all others in cm)

Measurement Name	Session	N	Mean	Standard Deviation	Minimum	Maximum	P-Value
Abdominal Ext. Depth, Sitting	2	25	3.90	1.84	-0.50	8.40	0.0001
Abdominal Ext. Depth, Sitting	3	22	7.50	1.97	4.60	12.30	0.0001
Abdominal Ext. Depth, Sitting	4	21	8.85	2.29	5.00	13.10	0.0001
Abdominal Ext. Depth, Sitting	5	17	11.00	2.35	7.80	17.00	0.0001
Abdominal Ext. Depth, Sitting	6	18	3.00	2.51	-0.50	7.80	0.0001
Ankle Circumference	2	25	0.10	1.10	-1.70	4.30	0.6671
Ankle Circumference	3	22	0.25	0.75	-1.50	1.40	0.1276
Ankle Circumference	4	21	0.30	0.84	-1.80	1.70	0.1170
Ankle Circumference	5	17	0.85	1.19	-1.70	3.30	0.0098
Ankle Circumference	6	18	-0.38	0.56	-2.00	0.50	0.0106
Buttock-Knee Length	2	25	0.23	0.65	-1.10	1.40	0.0857
Buttock-Knee Length	3	22	0.99	0.79	-0.20	2.70	0.0001
Buttock-Knee Length	4	21	1.01	0.67	-0.30	2.70	0.0001
Buttock-Knee Length	5	17	1.15	0.91	-0.10	3.40	0.0001
Buttock-Knee Length	6	18	0.46	0.90	-1.20	1.80	0.0452
Calf Circumference	2	25	0.33	0.47	-0.60	1.10	0.0021
Calf Circumference	3	22	0.95	0.61	-0.30	1.80	0.0001
Calf Circumference	4	21	1.20	0.88	-0.30	3.20	0.0001
Calf Circumference	5	17	1.54	0.90	0.10	3.60	0.0001
Calf Circumference	6	18	-0.24	0.74	-2.50	0.70	0.1798
Cervicale Height, Sitting	2	25	0.22	0.93	-1.90	3.20	0.2485
Cervicale Height, Sitting	3	22	-0.02	0.78	-1.60	1.30	0.9141
Cervicale Height, Sitting	4	21	-0.21	0.91	-1.90	1.30	0.2917
Cervicale Height, Sitting	5	17	-0.09	0.69	-1.30	1.00	0.6076
Cervicale Height, Sitting	6	18	-0.47	1.06	-2.30	1.00	0.0760
Cervicale Height	2	25	-0.13	0.62	-1.20	1.40	0.3139
Cervicale Height	3	22	-0.32	0.82	-1.80	1.10	0.0815
Cervicale Height	4	21	-0.57	0.88	-2.30	0.70	0.0076
Cervicale Height	5	17	-0.39	0.79	-1.60	0.90	0.0564
Cervicale Height	6	18	-0.76	0.99	-2.60	0.90	0.0047
Chest Breadth	2	25	1.02	0.94	-0.40	2.90	0.0001
Chest Breadth	3	22	2.11	0.83	0.80	3.80	0.0001
Chest Breadth	4	21	2.16	1.12	-0.30	4.40	0.0001
Chest Breadth	5	17	2.29	1.07	0.10	4.00	0.0001
Chest Breadth	6	18	1.01	1.06	-0.80	2.80	0.0009

**Summary Statistics for the Changes from Baseline for Subjects who Completed the  
Baseline Session and at Least One Additional Session**

Measurement Name	Session	N	Mean	Standard Deviation	Minimum	Maximum	P-Value
Chest Breadth Below Bust	2	25	0.46	0.70	-0.70	2.10	0.0032
Chest Breadth Below Bust	3	22	1.23	0.63	-0.10	2.20	0.0001
Chest Breadth Below Bust	4	21	1.22	0.86	-0.50	2.80	0.0001
Chest Breadth Below Bust	5	17	1.59	0.81	.00	2.90	0.0001
Chest Breadth Below Bust	6	18	-0.10	0.72	-1.30	0.80	0.5653
Chest Circumference	2	25	3.48	2.26	-0.20	8.70	0.0001
Chest Circumference	3	22	6.68	2.42	2.40	12.30	0.0001
Chest Circumference	4	21	7.20	3.21	-0.90	12.90	0.0001
Chest Circumference	5	17	9.09	2.89	4.50	14.60	0.0001
Chest Circumference	6	18	6.20	3.54	0.60	13.60	0.0001
Chest Circumference Below Bust	2	25	2.56	1.99	-0.30	7.80	0.0001
Chest Circumference Below Bust	3	22	5.24	2.25	1.40	9.50	0.0001
Chest Circumference Below Bust	4	21	5.70	3.09	-1.00	1.00	0.0001
Chest Circumference Below Bust	5	17	7.77	2.90	1.90	13.20	0.0001
Chest Circumference Below Bust	6	18	1.89	2.33	-2.10	7.50	0.0030
Chest Depth	2	25	0.94	0.66	-0.20	2.40	0.0001
Chest Depth	3	22	1.76	0.57	0.70	2.90	0.0001
Chest Depth	4	21	1.76	0.87	-0.80	3.20	0.0001
Chest Depth	5	17	1.94	0.85	0.70	3.50	0.0001
Chest Depth	6	18	1.17	1.00	-1.10	2.70	0.0001
Chest Depth Below Bust	2	25	0.74	0.78	-1.40	2.50	0.0001
Chest Depth Below Bust	3	22	1.70	0.77	0.40	3.40	0.0001
Chest Depth Below Bust	4	21	2.12	1.12	-0.80	3.50	0.0001
Chest Depth Below Bust	5	17	2.34	1.05	0.20	4.20	0.0001
Chest Depth Below Bust	6	18	0.12	1.01	-2.30	2.00	0.6142
Chest Height	2	25	0.20	1.18	-2.30	2.40	0.4033
Chest Height	3	22	0.79	1.24	-1.00	4.10	0.0072
Chest Height	4	21	0.54	1.24	-1.90	3.10	0.0588
Chest Height	5	17	1.13	1.28	-1.00	3.30	0.0022
Chest Height	6	17	-1.72	0.94	-3.30	-0.50	0.0001
Chest Height Below Bust	2	25	-0.28	0.91	-2.40	1.30	0.1361
Chest Height Below Bust	3	22	0.30	1.18	-2.50	2.60	0.2550
Chest Height Below Bust	4	21	0.23	1.24	-2.00	2.90	0.4082
Chest Height Below Bust	5	17	0.78	1.31	-0.80	3.70	0.0258
Chest Height Below Bust	6	18	-2.08	1.25	-3.90	.00	0.0001

**Summary Statistics for the Changes from Baseline for Subjects who Completed the  
Baseline Session and at Least One Additional Session**

Measurement Name	Session	N	Mean	Standard Deviation	Minimum	Maximum	P-Value
Foot Breadth	2	25	-0.18	0.29	-0.90	0.30	0.0062
Foot Breadth	3	22	-0.25	0.29	-1.00	0.20	0.0008
Foot Breadth	4	21	-0.15	0.32	-0.70	0.50	0.0495
Foot Breadth	5	17	-0.16	0.35	-1.00	0.50	0.0701
Foot Breadth	6	18	-0.18	0.43	-0.80	0.80	0.0911
Hand Breadth	2	25	-.03	0.17	-0.40	0.30	0.4238
Hand Breadth	3	22	.08	0.13	-0.20	0.40	0.0095
Hand Breadth	4	21	.08	0.17	-0.30	0.40	0.0372
Hand Breadth	5	17	0.14	0.17	-0.10	0.40	0.0034
Hand Breadth	6	18	.09	0.13	-0.10	0.30	0.0090
Hip Breadth	2	25	0.88	0.72	-0.50	2.20	0.0001
Hip Breadth	3	22	1.54	0.78	-0.30	3.00	0.0001
Hip Breadth	4	21	1.39	0.73	0.30	2.70	0.0001
Hip Breadth	5	17	1.33	0.71	0.10	2.70	0.0001
Hip Breadth	6	18	0.74	0.79	-0.50	2.30	0.0009
Hip Breadth, Sitting	2	25	1.17	0.90	-0.30	3.20	0.0001
Hip Breadth, Sitting	3	22	2.00	0.87	0.90	4.40	0.0001
Hip Breadth, Sitting	4	21	2.14	0.96	0.60	4.80	0.0001
Hip Breadth, Sitting	5	17	2.10	0.93	1.10	4.50	0.0001
Hip Breadth, Sitting	6	18	1.01	1.07	-0.50	2.90	0.0009
Hip Circumference	2	25	2.84	2.20	-3.10	6.60	0.0001
Hip Circumference	3	22	5.23	2.10	0.60	9.10	0.0001
Hip Circumference	4	21	5.94	2.64	-1.30	1.00	0.0001
Hip Circumference	5	17	7.34	2.14	4.10	12.10	0.0001
Hip Circumference	6	18	2.46	5.49	-17.60	7.90	0.0747
Knee Height, Sitting	2	25	0.15	0.49	-0.60	1.20	0.1447
Knee Height, Sitting	3	22	0.45	0.45	-0.30	1.40	0.0001
Knee Height, Sitting	4	21	0.46	0.46	-0.20	1.40	0.0002
Knee Height, Sitting	5	17	0.64	0.37	.00	1.30	0.0001
Knee Height, Sitting	6	18	0.40	0.48	-0.40	1.20	0.0025
Patella Top Height	2	25	-.08	0.62	-1.10	1.30	0.5226
Patella Top Height	3	22	0.23	0.77	-1.20	2.00	0.1728
Patella Top Height	4	21	.04	0.89	-1.50	1.50	0.8282
Patella Top Height	5	17	0.41	0.78	-1.20	1.60	0.0460
Patella Top Height	6	18	.08	0.78	-1.30	1.50	0.6561

**Summary Statistics for the Changes from Baseline for Subjects who Completed the  
Baseline Session and at Least One Additional Session**

Measurement Name	Session	N	Mean	Standard Deviation	Minimum	Maximum	P-Value
Sitting Height	2	25	0.40	0.69	-0.60	3.10	0.0078
Sitting Height	3	22	0.35	0.58	-0.60	1.50	0.0098
Sitting Height	4	21	0.15	0.53	-0.80	1.40	0.2008
Sitting Height	5	17	-.07	0.50	-1.00	0.90	0.5665
Sitting Height	6	18	-0.40	0.68	-1.60	0.90	0.0227
Stature	2	25	.08	0.56	-0.80	1.50	0.4835
Stature	3	22	.02	0.63	-0.80	1.50	0.8941
Stature	4	21	-0.22	0.63	-1.50	0.90	0.1196
Stature	5	17	-0.15	0.46	-0.80	0.80	0.1854
Stature	6	18	-0.82	0.59	-1.80	0.20	0.0001
Substernale Height	2	25	0.63	1.29	-2.30	3.30	0.0223
Substernale Height	3	22	1.82	1.71	-0.90	4.50	0.0001
Substernale Height	4	21	1.50	2.05	-2.50	4.80	0.0032
Substernale Height	5	17	1.61	1.96	-2.30	5.40	0.0038
Substernale Height	6	18	-0.89	1.40	-2.80	2.40	0.0149
Suprasternale Height	2	25	.02	0.54	-1.10	1.30	0.8264
Suprasternale Height	3	22	0.35	0.69	-1.50	1.40	0.0277
Suprasternale Height	4	21	.09	0.85	-1.90	1.40	0.6323
Suprasternale Height	5	17	.07	0.69	-1.20	1.20	0.6771
Suprasternale Height	6	18	-0.70	0.77	-2.10	0.50	0.0013
Tenth Rib Height	2	25	0.88	1.46	-1.50	4.10	0.0058
Tenth Rib Height	3	22	2.45	1.61	-1.20	5.60	0.0001
Tenth Rib Height	4	21	2.93	1.05	0.90	4.60	0.0001
Tenth Rib Height	5	17	3.44	1.60	0.80	6.60	0.0001
Tenth Rib Height	6	18	-0.26	1.02	-2.30	1.30	0.3005
Thigh Circumference, Proximal	2	25	1.60	1.43	-2.60	3.90	0.0001
Thigh Circumference, Proximal	3	22	2.86	1.66	-1.20	6.50	0.0001
Thigh Circumference, Proximal	4	21	3.08	2.16	-1.90	7.40	0.0001
Thigh Circumference, Proximal	5	17	3.52	1.90	-0.50	7.60	0.0001
Thigh Circumference, Proximal	6	18	1.21	1.53	-1.80	3.70	0.0039
Thumbtip Reach, Right	2	25	-.02	1.28	-2.60	2.90	0.9507
Thumbtip Reach, Right	3	22	-.02	1.67	-3.90	2.80	0.9598
Thumbtip Reach, Right	4	21	.06	2.02	-4.70	5.40	0.8984
Thumbtip Reach, Right	5	17	-0.58	1.84	-3.80	2.00	0.2148
Thumbtip Reach, Right	6	18	0.26	1.61	-2.80	2.50	0.5014

**Summary Statistics for the Changes from Baseline for Subjects who Completed the  
Baseline Session and at Least One Additional Session**

Measurement Name	Session	N	Mean	Standard Deviation	Minimum	Maximum	P-Value
Weight	2	25	9.84	4.19	2.30	18.50	0.0001
Weight	3	22	19.84	4.67	13.00	31.00	0.0001
Weight	4	21	22.17	7.26	-0.50	36.50	0.0001
Weight	5	17	29.66	6.66	19.50	49.00	0.0001
Weight	6	18	7.14	5.48	-2.00	19.30	0.0001
Waist Breadth, Omphalion	2	25	1.28	1.31	-1.20	4.80	0.0001
Waist Breadth, Omphalion	3	22	2.87	1.57	0.70	5.40	0.0001
Waist Breadth, Omphalion	4	21	3.23	1.76	0.20	6.40	0.0001
Waist Breadth, Omphalion	5	17	3.96	1.72	0.50	7.00	0.0001
Waist Breadth, Omphalion	6	18	2.19	2.11	-1.00	6.30	0.0004
Waist Breadth, Preferred	2	25	1.22	1.65	-2.10	5.10	0.0011
Waist Breadth, Preferred	3	22	2.20	1.35	-1.30	4.70	0.0001
Waist Breadth, Preferred	4	21	2.38	1.53	-1.00	5.10	0.0001
Waist Breadth, Preferred	5	17	2.95	1.58	-0.40	5.50	0.0001
Waist Breadth, Preferred	6	18	1.86	1.36	0.20	4.30	0.0001
Waist Circumference, Omphalion	2	25	1.03	4.47	2.00	19.20	0.0001
Waist Circumference, Omphalion	3	22	18.92	5.09	8.40	27.80	0.0001
Waist Circumference, Omphalion	4	21	21.76	6.06	9.80	34.50	0.0001
Waist Circumference, Omphalion	5	17	27.65	5.02	18.30	38.70	0.0001
Waist Circumference, Omphalion	6	18	8.37	5.67	-0.10	17.20	0.0001
Waist Circumference, Preferred	2	25	7.72	4.96	.00	19.50	0.0001
Waist Circumference, Preferred	3	22	13.45	4.31	7.40	23.60	0.0001
Waist Circumference, Preferred	4	21	15.82	6.44	-0.30	26.90	0.0001
Waist Circumference, Preferred	5	17	19.89	6.20	7.20	29.00	0.0001
Waist Circumference, Preferred	6	18	7.37	3.89	-0.40	15.20	0.0001
Waist Depth, Omphalion	2	25	4.20	1.82	0.40	8.40	0.0001
Waist Depth, Omphalion	3	22	8.17	1.85	4.10	12.10	0.0001
Waist Depth, Omphalion	4	21	9.36	2.24	4.00	14.20	0.0001
Waist Depth, Omphalion	5	17	12.26	1.96	9.30	16.70	0.0001
Waist Depth, Omphalion	6	18	2.02	2.07	-1.10	5.70	0.0007
Waist Depth, Preferred	2	25	3.16	1.56	.00	5.70	0.0001
Waist Depth, Preferred	3	22	5.73	1.77	2.40	9.90	0.0001
Waist Depth, Preferred	4	21	7.10	2.30	1.00	10.30	0.0001
Waist Depth, Preferred	5	17	9.02	2.50	3.50	12.60	0.0001
Waist Depth, Preferred	6	18	1.97	1.42	-0.10	4.80	0.0001

**Summary Statistics for the Changes from Baseline for Subjects who Completed the  
Baseline Session and at Least One Additional Session**

Measurement Name	Session	N	Mean	Standard Deviation	Minimum	Maximum	P-Value
Waist Height, Omphalion	2	25	-0.39	0.94	-3.10	1.40	0.0491
Waist Height, Omphalion	3	22	-0.83	1.77	-3.40	4.90	0.0401
Waist Height, Omphalion	4	21	-1.22	1.62	-5.20	2.10	0.0025
Waist Height, Omphalion	5	17	-1.98	1.59	-4.60	2.30	0.0001
Waist Height, Omphalion	6	18	-0.89	1.02	-3.20	0.10	0.0018
Waist Height, Preferred	2	25	1.27	3.22	-5.90	6.80	0.0596
Waist Height, Preferred	3	22	3.50	5.10	-11.50	10.30	0.0041
Waist Height, Preferred	4	21	3.09	5.40	-13.10	11.60	0.0164
Waist Height, Preferred	5	17	2.33	6.46	-13.80	9.60	0.1566
Waist Height, Preferred	6	18	-0.54	1.69	-3.40	2.90	0.1887

## **Appendix J: INTEGRATE**



INTEGRATE is a software tool developed by Sytronics, Inc. for the CARD Laboratory to visualize, analyze, and manipulate the scanned data acquired with the Cyberware whole-body scanner. This software generally will allow the analyst to manipulate and analyze the data in a variety of ways. The software will automatically measure attributes and such features as volume and surface area or edit scanned data isolating features from the entire whole-body scan for further comparison.

## **Appendix K: Average Ratio of Distances Between Sessions**

Sessions	Distance Ratio of 1 to 2	Distance Ratio of 1 to 3	Distance Ratio of 1 to 4	Distance Ratio of 1 to 5	Distance Ratio of 1 to 6	Distance Ratio of 1 to 7
1 to 2	0.98	0.99	1.00	1.01	0.99	0.98
1 to 3	0.99	0.99	1.00	1.01	0.98	0.97
1 to 4	0.99	0.97	0.99	0.99	0.98	0.98
1 to 5	0.99	0.98	0.99	1.00	0.98	0.98
1 to 6	1.00	0.99	0.99	1.00	0.97	0.96
2 to 3	1.01	1.00	1.01	1.01	0.99	0.99
2 to 4	1.01	0.98	0.99	0.98	0.99	1.00
2 to 5	1.01	0.99	0.99	1.00	0.99	1.00
2 to 6	1.02	1.00	0.99	0.99	0.98	0.98
3 to 4	1.00	0.98	0.98	0.98	1.00	1.00
3 to 5	1.00	0.99	0.99	0.99	1.00	1.01
3 to 6	1.01	1.00	0.99	0.98	0.99	0.99
4 to 5	1.01	1.01	1.00	1.01	1.00	1.00
4 to 6	1.01	1.02	1.00	1.01	0.99	0.98
5 to 6	1.01	1.01	1.00	0.99	0.99	0.98

Sessions	Distance Ratio of 1 to 8	Distance Ratio of 1 to 9	Distance Ratio of 1 to 10	Distance Ratio of 1 to 11	Distance Ratio of 1 to 12	Distance Ratio of 1 to 13
1 to 2	1.04	1.03	1.04	1.04	1.00	1.00
1 to 3	1.01	1.04	1.04	1.03	0.97	0.97
1 to 4	1.03	1.04	1.05	1.04	0.96	0.95
1 to 5	1.01	1.04	1.05	1.04	0.97	0.96
1 to 6	0.97	1.05	1.05	1.03	1.00	0.99
2 to 3	0.97	1.00	1.00	0.99	0.97	0.97
2 to 4	0.99	1.01	1.01	1.00	0.97	0.96
2 to 5	0.97	1.01	1.01	1.00	0.97	0.97
2 to 6	0.93	1.01	1.01	0.99	1.00	1.00
3 to 4	1.02	1.00	1.01	1.01	1.00	0.99
3 to 5	1.00	1.01	1.01	1.01	1.00	0.99
3 to 6	0.96	1.01	1.01	1.00	1.03	1.03
4 to 5	0.98	1.00	1.00	1.00	1.01	1.01
4 to 6	0.95	1.01	1.00	1.00	1.03	1.04
5 to 6	0.96	1.01	1.00	0.99	1.03	1.03

Sessions	Distance Ratio of 1 to 14	Distance Ratio of 1 to 15	Distance Ratio of 1 to 16	Distance Ratio of 1 to 17	Distance Ratio of 2 to 3	Distance Ratio of 2 to 4
1 to 2	1.01	1.05	1.01	1.01	1.00	1.01
1 to 3	1.00	1.08	1.01	1.00	1.00	1.01
1 to 4	1.03	1.12	1.02	1.01	0.96	0.99
1 to 5	1.07	1.14	1.03	1.03	0.97	0.99
1 to 6	1.01	1.01	0.99	0.98	0.97	0.98
2 to 3	0.99	1.03	0.99	0.99	0.99	1.01
2 to 4	1.02	1.07	1.01	1.00	0.96	0.98
2 to 5	1.06	1.09	1.02	1.02	0.97	0.98
2 to 6	1.00	0.96	0.98	0.97	0.97	0.98
3 to 4	1.03	1.04	1.02	1.01	0.97	0.97
3 to 5	1.07	1.06	1.03	1.03	0.98	0.97
3 to 6	1.01	0.93	0.99	0.98	0.98	0.97
4 to 5	1.03	1.02	1.01	1.02	1.01	1.00
4 to 6	0.99	0.90	0.97	0.97	1.02	1.00
5 to 6	0.96	0.88	0.96	0.95	1.01	1.00

Sessions	Distance Ratio of 2 to 5	Distance Ratio of 2 to 6	Distance Ratio of 2 to 7	Distance Ratio of 2 to 8	Distance Ratio of 2 to 9	Distance Ratio of 2 to 10
1 to 2	1.01	0.99	0.98	1.04	1.04	1.05
1 to 3	1.02	0.98	0.97	1.04	1.06	1.06
1 to 4	0.99	0.98	0.98	1.04	1.06	1.06
1 to 5	1.00	0.98	0.98	1.00	1.06	1.06
1 to 6	1.00	0.96	0.96	0.99	1.05	1.05
2 to 3	1.01	0.99	0.99	1.01	1.01	1.01
2 to 4	0.98	0.99	1.00	1.00	1.01	1.02
2 to 5	0.99	0.99	1.00	0.96	1.01	1.01
2 to 6	0.99	0.97	0.98	0.96	1.01	1.00
3 to 4	0.97	1.00	1.01	1.00	1.00	1.01
3 to 5	0.98	1.00	1.00	0.96	1.00	1.00
3 to 6	0.98	0.99	0.98	0.95	1.00	1.00
4 to 5	1.01	1.00	1.00	0.96	1.00	1.00
4 to 6	1.01	0.98	0.98	0.95	1.00	0.99
5 to 6	1.00	0.98	0.98	0.99	1.00	0.99

Sessions	Distance Ratio of 2 to 11	Distance Ratio of 2 to 12	Distance Ratio of 2 to 13	Distance Ratio of 2 to 14	Distance Ratio of 2 to 15	Distance Ratio of 2 to 16
1 to 2	1.05	1.02	1.01	1.03	1.07	1.02
1 to 3	1.05	0.99	0.98	1.04	1.12	1.02
1 to 4	1.06	0.98	0.97	1.08	1.17	1.03
1 to 5	1.05	0.99	0.97	1.12	1.19	1.04
1 to 6	1.04	1.00	0.99	1.02	1.02	1.00
2 to 3	1.00	0.98	0.98	1.01	1.05	1.00
2 to 4	1.01	0.97	0.96	1.05	1.09	1.01
2 to 5	1.00	0.98	0.97	1.08	1.11	1.02
2 to 6	0.99	0.99	0.99	0.99	0.95	0.98
3 to 4	1.01	0.99	0.99	1.04	1.04	1.02
3 to 5	1.00	1.00	0.99	1.08	1.06	1.03
3 to 6	0.99	1.02	1.01	0.99	0.91	0.99
4 to 5	1.00	1.01	1.01	1.03	1.02	1.01
4 to 6	0.98	1.02	1.03	0.96	0.88	0.97
5 to 6	0.99	1.01	1.02	0.93	0.86	0.96

Sessions	Distance Ratio of 2 to 17	Distance Ratio of 3 to 4	Distance Ratio of 3 to 5	Distance Ratio of 3 to 6	Distance Ratio of 3 to 7	Distance Ratio of 3 to 8
1 to 2	1.01	1.01	1.02	0.99	0.97	1.03
1 to 3	1.00	1.04	1.04	0.97	0.97	1.04
1 to 4	1.02	1.02	1.01	1.00	0.99	1.02
1 to 5	1.03	1.02	1.03	0.99	0.98	1.01
1 to 6	0.98	1.01	1.03	0.97	0.96	1.01
2 to 3	0.99	1.03	1.02	0.99	1.00	1.01
2 to 4	1.00	1.01	0.99	1.01	1.02	1.00
2 to 5	1.02	1.00	1.01	1.00	1.01	0.99
2 to 6	0.97	1.00	1.01	0.98	0.99	0.99
3 to 4	1.01	0.98	0.98	1.02	1.02	0.99
3 to 5	1.03	0.98	0.99	1.02	1.02	0.98
3 to 6	0.98	0.97	0.99	1.00	0.99	0.98
4 to 5	1.02	1.00	1.02	1.00	1.00	0.99
4 to 6	0.97	0.99	1.01	0.98	0.97	0.99
5 to 6	0.95	0.99	1.00	0.98	0.97	1.00

Sessions	Distance Ratio of 3 to 9	Distance Ratio of 3 to 10	Distance Ratio of 3 to 11	Distance Ratio of 3 to 12	Distance Ratio of 3 to 13	Distance Ratio of 3 to 14
1 to 2	1.05	1.05	1.06	1.04	1.02	1.07
1 to 3	1.07	1.07	1.07	1.03	1.01	1.10
1 to 4	1.08	1.09	1.09	1.03	1.02	1.16
1 to 5	1.09	1.09	1.09	1.06	1.03	1.21
1 to 6	1.07	1.07	1.07	1.04	1.02	1.06
2 to 3	1.02	1.02	1.01	0.99	0.99	1.03
2 to 4	1.03	1.03	1.02	0.99	0.99	1.09
2 to 5	1.04	1.04	1.03	1.02	1.01	1.14
2 to 6	1.02	1.01	1.00	1.00	1.00	1.00
3 to 4	1.01	1.01	1.01	1.00	1.00	1.06
3 to 5	1.02	1.02	1.02	1.03	1.02	1.11
3 to 6	1.00	0.99	0.99	1.01	1.01	0.97
4 to 5	1.01	1.00	1.01	1.03	1.02	1.05
4 to 6	0.99	0.98	0.98	1.01	1.01	0.93
5 to 6	0.98	0.98	0.97	0.98	0.99	0.89

Sessions	Distance Ratio of 3 to 15	Distance Ratio of 3 to 16	Distance Ratio of 3 to 17	Distance Ratio of 4 to 5	Distance Ratio of 4 to 6	Distance Ratio of 4 to 7
1 to 2	1.11	1.03	1.02	1.03	0.97	0.96
1 to 3	1.18	1.03	1.02	1.04	0.95	0.94
1 to 4	1.25	1.06	1.04	1.01	0.99	0.99
1 to 5	1.29	1.07	1.06	1.04	0.98	0.97
1 to 6	1.06	1.02	1.00	1.05	0.95	0.93
2 to 3	1.07	1.00	0.99	1.02	0.98	0.99
2 to 4	1.13	1.03	1.02	0.99	1.02	1.03
2 to 5	1.16	1.04	1.04	1.02	1.01	1.02
2 to 6	0.95	0.99	0.98	1.02	0.98	0.97
3 to 4	1.06	1.03	1.03	0.97	1.04	1.05
3 to 5	1.09	1.04	1.05	1.00	1.04	1.04
3 to 6	0.89	0.99	0.99	1.01	1.01	1.00
4 to 5	1.03	1.01	1.02	1.04	1.00	0.99
4 to 6	0.85	0.97	0.96	1.04	0.97	0.95
5 to 6	0.82	0.96	0.94	1.01	0.97	0.97

Sessions	Distance Ratio of 4 to 8	Distance Ratio of 4 to 9	Distance Ratio of 4 to 10	Distance Ratio of 4 to 11	Distance Ratio of 4 to 12	Distance Ratio of 4 to 13
1 to 2	1.01	1.03	1.04	1.05	1.06	1.05
1 to 3	1.03	1.06	1.06	1.07	1.08	1.06
1 to 4	1.01	1.07	1.07	1.08	1.09	1.08
1 to 5	1.00	1.08	1.07	1.09	1.13	1.10
1 to 6	1.00	1.04	1.03	1.04	1.05	1.03
2 to 3	1.02	1.03	1.02	1.02	1.02	1.01
2 to 4	1.00	1.03	1.03	1.03	1.03	1.03
2 to 5	0.99	1.04	1.03	1.04	1.07	1.05
2 to 6	0.99	1.01	1.00	1.00	0.99	0.98
3 to 4	0.98	1.01	1.01	1.01	1.01	1.02
3 to 5	0.97	1.02	1.01	1.02	1.05	1.04
3 to 6	0.98	0.98	0.98	0.98	0.97	0.98
4 to 5	0.99	1.01	1.00	1.01	1.04	1.02
4 to 6	1.00	0.97	0.96	0.96	0.96	0.96
5 to 6	1.00	0.96	0.96	0.96	0.92	0.94

Sessions	Distance Ratio of 4 to 14	Distance Ratio of 4 to 15	Distance Ratio of 4 to 16	Distance Ratio of 4 to 17	Distance Ratio of 5 to 6	Distance Ratio of 5 to 7
1 to 2	1.12	1.16	1.04	1.03	0.86	0.90
1 to 3	1.18	1.26	1.04	1.02	0.84	0.87
1 to 4	1.27	1.35	1.08	1.06	0.96	1.03
1 to 5	1.34	1.41	1.10	1.08	0.95	0.93
1 to 6	1.09	1.08	1.03	1.01	0.91	0.85
2 to 3	1.06	1.09	1.00	0.99	1.01	0.98
2 to 4	1.14	1.17	1.04	1.03	1.15	1.16
2 to 5	1.20	1.22	1.06	1.06	1.15	1.08
2 to 6	0.98	0.94	1.00	0.98	1.09	0.97
3 to 4	1.07	1.07	1.04	1.05	1.16	1.19
3 to 5	1.13	1.12	1.06	1.07	1.16	1.12
3 to 6	0.93	0.86	1.00	0.99	1.13	1.04
4 to 5	1.05	1.04	1.02	1.02	1.01	0.94
4 to 6	0.87	0.80	0.96	0.95	0.97	0.87
5 to 6	0.83	0.77	0.94	0.93	0.98	0.96

Sessions	Distance Ratio of 5 to 8	Distance Ratio of 5 to 9	Distance Ratio of 5 to 10	Distance Ratio of 5 to 11	Distance Ratio of 5 to 12	Distance Ratio of 5 to 13
1 to 2	1.01	1.03	1.03	1.04	1.09	1.09
1 to 3	1.04	1.06	1.06	1.08	1.17	1.16
1 to 4	1.00	1.04	1.05	1.05	1.15	1.15
1 to 5	1.01	1.07	1.07	1.08	1.21	1.20
1 to 6	1.00	0.99	0.99	1.00	1.02	1.01
2 to 3	1.02	1.04	1.03	1.04	1.07	1.06
2 to 4	0.99	1.02	1.02	1.02	1.05	1.06
2 to 5	1.00	1.04	1.03	1.04	1.12	1.10
2 to 6	0.99	0.97	0.96	0.97	0.94	0.93
3 to 4	0.97	0.98	0.99	0.98	0.98	1.00
3 to 5	0.98	1.01	1.00	1.00	1.04	1.04
3 to 6	0.97	0.94	0.94	0.93	0.87	0.88
4 to 5	1.01	1.03	1.02	1.03	1.06	1.05
4 to 6	1.00	0.96	0.95	0.95	0.89	0.88
5 to 6	0.99	0.93	0.93	0.93	0.84	0.85

Sessions	Distance Ratio of 5 to 14	Distance Ratio of 5 to 15	Distance Ratio of 5 to 16	Distance Ratio of 5 to 17	Distance Ratio of 6 to 7	Distance Ratio of 6 to 8
1 to 2	1.20	1.21	1.05	1.04	0.96	0.99
1 to 3	1.35	1.38	1.08	1.06	1.01	0.99
1 to 4	1.41	1.46	1.11	1.11	1.11	0.99
1 to 5	1.51	1.55	1.14	1.13	1.11	0.99
1 to 6	1.08	1.07	1.02	1.01	1.05	0.96
2 to 3	1.12	1.14	1.02	1.02	1.16	1.00
2 to 4	1.18	1.21	1.06	1.06	1.20	1.00
2 to 5	1.26	1.28	1.08	1.08	1.21	1.00
2 to 6	0.91	0.89	0.98	0.96	1.15	0.98
3 to 4	1.05	1.06	1.03	1.04	1.06	1.00
3 to 5	1.12	1.12	1.06	1.06	1.08	1.00
3 to 6	0.81	0.78	0.96	0.95	1.03	0.98
4 to 5	1.07	1.06	1.02	1.02	1.02	1.00
4 to 6	0.78	0.74	0.93	0.91	0.97	0.98
5 to 6	0.73	0.70	0.90	0.89	0.96	0.98



Sessions	Distance Ratio of 6 to 9	Distance Ratio of 6 to 10	Distance Ratio of 6 to 11	Distance Ratio of 6 to 12	Distance Ratio of 6 to 13	Distance Ratio of 6 to 14
1 to 2	1.00	1.00	1.00	1.06	1.03	1.15
1 to 3	1.00	1.01	1.01	1.10	1.08	1.27
1 to 4	1.01	1.02	1.02	1.11	1.10	1.34
1 to 5	1.02	1.02	1.03	1.15	1.14	1.40
1 to 6	0.94	0.96	0.95	0.95	0.98	1.03
2 to 3	1.00	1.02	1.02	1.04	1.05	1.11
2 to 4	1.01	1.02	1.02	1.05	1.07	1.17
2 to 5	1.02	1.03	1.03	1.09	1.10	1.22
2 to 6	0.94	0.97	0.95	0.90	0.95	0.91
3 to 4	1.01	1.01	1.01	1.01	1.02	1.05
3 to 5	1.02	1.02	1.02	1.05	1.05	1.09
3 to 6	0.94	0.96	0.94	0.86	0.91	0.82
4 to 5	1.01	1.01	1.01	1.04	1.03	1.04
4 to 6	0.93	0.95	0.94	0.86	0.89	0.78
5 to 6	0.93	0.94	0.93	0.83	0.87	0.75

Sessions	Distance Ratio of 6 to 15	Distance Ratio of 6 to 16	Distance Ratio of 6 to 17	Distance Ratio of 7 to 8	Distance Ratio of 7 to 9	Distance Ratio of 7 to 10
1 to 2	1.16	1.07	1.02	0.98	0.99	0.99
1 to 3	1.30	1.09	1.07	0.99	1.01	1.00
1 to 4	1.37	1.12	1.10	0.98	1.01	1.00
1 to 5	1.45	1.14	1.13	0.98	1.02	1.01
1 to 6	1.03	1.03	1.02	0.96	0.95	0.94
2 to 3	1.12	1.02	1.04	1.01	1.02	1.01
2 to 4	1.18	1.05	1.07	1.00	1.03	1.01
2 to 5	1.25	1.06	1.10	1.00	1.04	1.03
2 to 6	0.89	0.96	1.00	0.98	0.97	0.95
3 to 4	1.05	1.03	1.03	1.00	1.01	1.01
3 to 5	1.11	1.05	1.05	1.00	1.02	1.02
3 to 6	0.80	0.95	0.96	0.97	0.95	0.94
4 to 5	1.06	1.02	1.03	1.00	1.01	1.01
4 to 6	0.76	0.93	0.93	0.98	0.94	0.94
5 to 6	0.72	0.91	0.91	0.98	0.93	0.93

Sessions	Distance Ratio of 7 to 11	Distance Ratio of 7 to 12	Distance Ratio of 7 to 13	Distance Ratio of 7 to 14	Distance Ratio of 7 to 15	Distance Ratio of 7 to 16
1 to 2	0.99	1.03	1.05	1.14	1.16	1.03
1 to 3	1.01	1.08	1.08	1.26	1.29	1.07
1 to 4	1.01	1.10	1.10	1.33	1.35	1.10
1 to 5	1.03	1.14	1.15	1.39	1.44	1.13
1 to 6	0.95	0.97	0.96	1.03	1.03	1.01
2 to 3	1.02	1.05	1.04	1.11	1.12	1.04
2 to 4	1.02	1.08	1.06	1.17	1.17	1.07
2 to 5	1.04	1.11	1.10	1.22	1.25	1.09
2 to 6	0.96	0.94	0.92	0.91	0.89	0.98
3 to 4	1.01	1.02	1.02	1.05	1.05	1.03
3 to 5	1.02	1.05	1.06	1.10	1.11	1.05
3 to 6	0.94	0.89	0.88	0.82	0.80	0.95
4 to 5	1.01	1.03	1.04	1.04	1.07	1.02
4 to 6	0.94	0.88	0.87	0.78	0.77	0.92
5 to 6	0.93	0.86	0.84	0.75	0.72	0.90

Sessions	Distance Ratio of 7 to 17	Distance Ratio of 8 to 9	Distance Ratio of 8 to 10	Distance Ratio of 8 to 11	Distance Ratio of 8 to 12	Distance Ratio of 8 to 13
1 to 2	1.07	1.03	1.04	1.04	0.99	0.99
1 to 3	1.08	1.06	1.06	1.04	0.96	0.96
1 to 4	1.10	1.04	1.06	1.04	0.95	0.93
1 to 5	1.13	1.05	1.07	1.04	0.95	0.94
1 to 6	1.03	1.09	1.11	1.07	1.01	1.00
2 to 3	1.00	1.03	1.02	1.01	0.97	0.98
2 to 4	1.03	1.02	1.01	1.00	0.96	0.95
2 to 5	1.06	1.03	1.02	1.00	0.96	0.95
2 to 6	0.97	1.07	1.06	1.03	1.02	1.02
3 to 4	1.02	0.99	1.00	1.00	0.99	0.97
3 to 5	1.05	1.00	1.01	1.00	0.99	0.98
3 to 6	0.96	1.04	1.04	1.03	1.05	1.04
4 to 5	1.03	1.01	1.01	1.01	1.00	1.01
4 to 6	0.94	1.05	1.04	1.03	1.06	1.07
5 to 6	0.92	1.04	1.04	1.03	1.06	1.07

Sessions	Distance Ratio of 8 to 14	Distance Ratio of 8 to 15	Distance Ratio of 8 to 16	Distance Ratio of 8 to 17	Distance Ratio of 9 to 10	Distance Ratio of 9 to 11
1 to 2	0.99	1.04	1.01	1.00	1.03	1.00
1 to 3	0.97	1.08	1.01	1.00	1.07	1.06
1 to 4	1.00	1.12	1.02	1.01	1.08	1.09
1 to 5	1.05	1.15	1.03	1.03	1.08	1.09
1 to 6	1.01	1.01	0.99	0.98	1.12	1.09
2 to 3	0.99	1.04	1.00	1.00	1.05	1.08
2 to 4	1.02	1.08	1.02	1.00	1.05	1.10
2 to 5	1.07	1.10	1.03	1.03	1.05	1.11
2 to 6	1.03	0.97	0.98	0.97	1.09	1.10
3 to 4	1.04	1.04	1.02	1.01	1.01	1.03
3 to 5	1.09	1.06	1.03	1.03	1.02	1.04
3 to 6	1.05	0.94	0.98	0.98	1.05	1.03
4 to 5	1.04	1.02	1.01	1.03	1.01	1.01
4 to 6	1.02	0.90	0.97	0.97	1.05	1.01
5 to 6	0.99	0.88	0.96	0.95	1.06	1.02

Sessions	Distance Ratio of 9 to 12	Distance Ratio of 9 to 13	Distance Ratio of 9 to 14	Distance Ratio of 9 to 15	Distance Ratio of 9 to 16	Distance Ratio of 9 to 17
1 to 2	0.96	1.01	0.94	1.01	0.99	1.00
1 to 3	0.86	1.03	0.89	1.05	0.98	1.02
1 to 4	0.87	1.01	0.94	1.13	1.02	1.03
1 to 5	0.83	1.01	1.00	1.15	1.03	1.06
1 to 6	0.93	1.02	0.95	0.96	0.92	0.95
2 to 3	0.91	1.02	0.96	1.04	0.99	1.01
2 to 4	0.92	1.01	1.03	1.12	1.02	1.03
2 to 5	0.88	1.01	1.11	1.14	1.04	1.07
2 to 6	0.98	1.02	1.04	0.95	0.93	0.95
3 to 4	1.02	0.98	1.08	1.07	1.04	1.01
3 to 5	0.97	0.98	1.16	1.10	1.05	1.05
3 to 6	1.09	1.00	1.10	0.91	0.94	0.94
4 to 5	0.96	1.00	1.06	1.03	1.02	1.04
4 to 6	1.08	1.02	1.05	0.86	0.91	0.92
5 to 6	1.14	1.02	1.02	0.84	0.90	0.89

Sessions	Distance Ratio of 10 to 11	Distance Ratio of 10 to 12	Distance Ratio of 10 to 13	Distance Ratio of 10 to 14	Distance Ratio of 10 to 15	Distance Ratio of 10 to 16
1 to 2	1.06	1.03	0.94	0.95	1.02	1.01
1 to 3	1.06	1.01	0.87	0.89	1.05	1.02
1 to 4	1.05	1.04	0.82	0.93	1.12	1.04
1 to 5	1.06	1.02	0.81	1.00	1.15	1.05
1 to 6	1.09	1.03	0.91	0.96	0.96	0.97
2 to 3	1.01	0.99	0.94	0.95	1.03	1.01
2 to 4	1.01	1.02	0.89	1.01	1.10	1.03
2 to 5	1.00	0.99	0.88	1.08	1.13	1.05
2 to 6	1.05	1.01	0.99	1.03	0.95	0.96
3 to 4	1.01	1.02	0.95	1.07	1.07	1.03
3 to 5	1.01	1.00	0.93	1.15	1.09	1.04
3 to 6	1.05	1.02	1.06	1.10	0.92	0.95
4 to 5	1.01	0.98	1.00	1.06	1.03	1.01
4 to 6	1.05	1.00	1.12	1.06	0.87	0.93
5 to 6	1.06	1.02	1.16	1.04	0.84	0.92

Sessions	Distance Ratio of 10 to 17	Distance Ratio of 11 to 12	Distance Ratio of 11 to 13	Distance Ratio of 11 to 14	Distance Ratio of 11 to 15	Distance Ratio of 11 to 16
1 to 2	0.98	0.99	1.00	0.90	1.01	1.00
1 to 3	0.96	0.97	0.99	0.84	1.08	1.02
1 to 4	0.98	1.00	0.95	0.90	1.16	1.05
1 to 5	1.02	0.97	0.95	0.99	1.19	1.06
1 to 6	0.90	1.01	0.99	0.93	0.95	0.95
2 to 3	0.98	0.98	1.01	0.97	1.07	1.01
2 to 4	1.00	1.01	0.97	1.05	1.15	1.04
2 to 5	1.04	0.97	0.96	1.11	1.18	1.06
2 to 6	0.92	1.02	1.01	1.09	0.94	0.95
3 to 4	1.02	1.03	0.96	1.11	1.08	1.03
3 to 5	1.06	0.99	0.95	1.23	1.11	1.05
3 to 6	0.93	1.04	1.01	1.16	0.89	0.94
4 to 5	1.05	0.97	1.00	1.07	1.04	1.02
4 to 6	0.92	1.01	1.05	1.13	0.83	0.91
5 to 6	0.88	1.06	1.08	1.20	0.81	0.90

Sessions	Distance Ratio of 11 to 17	Distance Ratio of 12 to 13	Distance Ratio of 12 to 14	Distance Ratio of 12 to 15	Distance Ratio of 12 to 16	Distance Ratio of 12 to 17
1 to 2	0.99	1.10	1.13	1.19	1.07	1.06
1 to 3	1.01	1.15	1.23	1.38	1.14	1.13
1 to 4	1.01	1.16	1.37	1.54	1.20	1.16
1 to 5	1.06	1.16	1.44	1.56	1.24	1.21
1 to 6	0.93	1.07	1.10	1.09	0.97	0.99
2 to 3	1.01	1.05	1.09	1.16	1.07	1.06
2 to 4	1.02	1.07	1.22	1.30	1.13	1.09
2 to 5	1.07	1.07	1.29	1.32	1.16	1.13
2 to 6	0.93	0.98	0.97	0.91	0.91	0.94
3 to 4	1.01	1.02	1.11	1.12	1.06	1.03
3 to 5	1.05	1.02	1.17	1.13	1.09	1.07
3 to 6	0.92	0.93	0.90	0.79	0.86	0.89
4 to 5	1.05	1.00	1.05	1.02	1.04	1.04
4 to 6	0.92	0.92	0.82	0.71	0.82	0.86
5 to 6	0.88	0.93	0.80	0.70	0.79	0.83

Sessions	Distance Ratio of 13 to 14	Distance Ratio of 13 to 15	Distance Ratio of 13 to 16	Distance Ratio of 13 to 17	Distance Ratio of 14 to 15	Distance Ratio of 14 to 16
1 to 2	1.16	1.20	1.07	1.05	1.55	1.17
1 to 3	1.27	1.39	1.13	1.08	2.55	1.31
1 to 4	1.35	1.52	1.18	1.15	2.94	1.42
1 to 5	1.47	1.58	1.21	1.23	3.10	1.47
1 to 6	1.10	1.09	1.02	0.94	1.47	1.01
2 to 3	1.11	1.17	1.05	1.03	2.49	1.15
2 to 4	1.19	1.27	1.09	1.09	2.97	1.22
2 to 5	1.30	1.33	1.12	1.17	2.73	1.26
2 to 6	0.95	0.91	0.95	0.89	1.18	0.87
3 to 4	1.07	1.10	1.04	1.07	1.14	1.06
3 to 5	1.17	1.15	1.06	1.14	1.22	1.11
3 to 6	0.87	0.79	0.90	0.88	0.56	0.76
4 to 5	1.08	1.05	1.02	1.07	1.22	1.05
4 to 6	0.83	0.72	0.87	0.82	0.58	0.72
5 to 6	0.79	0.69	0.85	0.77	0.63	0.69

Sessions	Distance Ratio of 14 to 17	Distance Ratio of 15 to 16	Distance Ratio of 15 to 17	Distance Ratio of 16 to 17
1 to 2	1.13	1.13	1.11	1.07
1 to 3	1.28	1.27	1.27	1.14
1 to 4	1.32	1.37	1.29	1.18
1 to 5	1.45	1.44	1.43	1.22
1 to 6	0.96	1.01	0.96	1.01
2 to 3	1.15	1.13	1.14	1.07
2 to 4	1.18	1.19	1.16	1.09
2 to 5	1.28	1.26	1.28	1.13
2 to 6	0.86	0.89	0.88	0.95
3 to 4	1.03	1.06	1.02	1.03
3 to 5	1.13	1.12	1.13	1.06
3 to 6	0.75	0.79	0.78	0.89
4 to 5	1.10	1.06	1.11	1.04
4 to 6	0.74	0.75	0.76	0.87
5 to 6	0.68	0.71	0.69	0.84

## **Appendix L: Influential EDMA Results**

**Table L-1. Influential Changes from Session 1 to 2.**

From	To	Ratio
Waist preferred	Waist omphalion	1.55
Cervicale -40	Waist omphalion	1.21
Cervicale -40	Waist preferred	1.20
Cervicale -30	Waist omphalion	1.16
Cervicale -30	Waist preferred	1.12
Cervicale -20	Waist omphalion	1.11
10th rib left	Waist omphalion	1.19
10th rib right	Waist omphalion	1.20
10th rib left	Waist preferred	1.13
10th rib right	Waist preferred	1.16
Waist preferred	ASIS left	1.17
Waist preferred	ASIS right	1.13
PSIS left	Waist omphalion	1.16
PSIS right	Waist omphalion	1.16
PSIS left	Waist preferred	1.15
PSIS right	Waist preferred	1.14
Waist omphalion	ASIS left	1.13
Waist omphalion	ASIS right	1.11
10th rib left	10th rib right	1.10
Cervicale -40	PSIS left	0.86
Cervicale -40	PSIS right	0.90

**Table L-2. Influential Changes from Session 1 to 3.**

From	To	Ratio
Waist preferred	Waist omphalion	2.55
10th rib left	Waist omphalion	1.38
10th rib right	Waist omphalion	1.39
Cervicale -40	Waist omphalion	1.38
Cervicale -40	Waist preferred	1.35
Cervicale -30	Waist omphalion	1.26
Waist preferred	ASIS left	1.31
Waist preferred	ASIS right	1.28
PSIS left	Waist omphalion	1.30
PSIS right	Waist omphalion	1.29
Waist omphalion	ASIS left	1.27
Waist omphalion	ASIS right	1.27
10th rib left	Waist preferred	1.23
10th rib right	Waist preferred	1.27
PSIS left	Waist preferred	1.27
PSIS right	Waist preferred	1.26



**Table L-3. Influential Changes from Session 1 to 4.**

From	To	Ratio
Waist preferred	Waist omphalion	2.94
10th rib left	Waist omphalion	1.54
10th rib right	Waist omphalion	1.52
Cervicale -40	Waist omphalion	1.46
Cervicale -40	Waist preferred	1.41
Cervicale -30	Waist omphalion	1.35
Waist preferred	ASIS left	1.42
Waist preferred	ASIS right	1.32
PSIS left	Waist omphalion	1.37
PSIS right	Waist omphalion	1.35
10th rib left	Waist preferred	1.37
10th rib right	Waist preferred	1.35
Waist omphalion	ASIS left	1.37
Waist omphalion	ASIS right	1.29
PSIS left	Waist preferred	1.34
PSIS right	Waist preferred	1.33

**Table L-4. Influential Changes from Session 1 to 5.**

From	To	Ratio
Waist preferred	Waist omphalion	3.10
10th rib left	Waist omphalion	1.56
10th rib right	Waist omphalion	1.58
Cervicale -40	Waist omphalion	1.55
Cervicale -40	Waist preferred	1.51
Cervicale -30	Waist omphalion	1.41
Waist preferred	ASIS left	1.47
Waist preferred	ASIS right	1.45
10th rib left	Waist preferred	1.44
10th rib right	Waist preferred	1.47
PSIS left	Waist omphalion	1.45
PSIS right	Waist omphalion	1.44
Waist omphalion	ASIS left	1.44
Waist omphalion	ASIS right	1.43
PSIS left	Waist preferred	1.40
PSIS right	Waist preferred	1.39

**Table L-5. Influential Changes from Session 1 to 6.**

From	To	Ratio
Waist preferred	Waist omphalion	1.47
Bustpoint left	Bustpoint right	1.12
Suprasternale	Bustpoint left	1.09
Suprasternale	Bustpoint right	1.11

**Table L-6. Influential Changes from Session 2 to 3.**

From	To	Ratio
Waist preferred	Waist omphalion	2.49
10th rib left	Waist omphalion	1.16
10th rib right	Waist omphalion	1.17
PSIS left	PSIS right	1.16
Waist preferred	ASIS left	1.15
Waist preferred	ASIS right	1.15
Cervicale -40	Waist omphalion	1.14
Cervicale -40	Waist preferred	1.12
Waist omphalion	ASIS left	1.13
Waist omphalion	ASIS right	1.14
PSIS left	Waist omphalion	1.12
PSIS right	Waist omphalion	1.12
PSIS left	Waist preferred	1.11
PSIS right	Waist preferred	1.11
10th rib left	Waist preferred	1.09
10th rib right	Waist preferred	1.11

**Table L-7. Influential Changes from Session 2 to 4.**

From	To	Ratio
Waist preferred	Waist omphalion	2.97
10th rib left	Waist omphalion	1.30
10th rib right	Waist omphalion	1.27
10th rib left	Waist preferred	1.22
10th rib right	Waist preferred	1.19
Waist preferred	ASIS left	1.22
Waist preferred	ASIS right	1.18
Cervicale -40	Waist omphalion	1.21
PSIS left	PSIS right	1.20

**Table L-8. Influential Changes from Session 2 to 5.**

From	To	Ratio
Waist preferred	Waist omphalion	2.73
10th rib left	Waist omphalion	1.32
10th rib right	Waist omphalion	1.33
10th rib left	Waist preferred	1.29
10th rib right	Waist preferred	1.30

**Table L-9. Influential Changes from Session 2 to 6.**

From	To	Ratio
Waist preferred	Waist omphalion	1.18
PSIS left	PSIS right	1.15

**Table L-10. Influential Changes from Session 3 to 4.**

From	To	Ratio
Cervicale -40	PSIS left	1.16
Cervicale -40	PSIS right	1.19
Waist preferred	Waist omphalion	1.14
10th rib left	Waist omphalion	1.12
10th rib right	Waist omphalion	1.10
10th rib left	Waist preferred	1.11
10th rib right	Waist preferred	1.07
Substernale	Waist preferred	1.11

**Table L-11. Influential Changes from Session 3 to 5.**

From	To	Ratio
Substernale	Waist preferred	1.23
Waist preferred	Waist omphalion	1.22

**Table L-12. Influential Changes from Session 3 to 6.**

From	To	Ratio
Waist preferred	Waist omphalion	0.56
Waist preferred	ASIS left	0.76
Waist preferred	ASIS right	0.75
Cervicale -40	Waist omphalion	0.78
Waist omphalion	ASIS left	0.79
Waist omphalion	ASIS right	0.78
10th rib left	Waist omphalion	0.79
10th rib right	Waist omphalion	0.79
PSIS left	Waist omphalion	0.80
PSIS right	Waist omphalion	0.80

**Table L-13. Influential Changes from Session 4 to 5.**

From	To	Ratio
Waist preferred	Waist omphalion	1.22
Waist omphalion	ASIS left	1.05
Waist omphalion	ASIS right	1.11
Waist preferred	ASIS left	1.05
Waist preferred	ASIS right	1.10

**Table L-14. Influential Changes from Session 4 to 6.**

From	To	Ratio
Waist preferred	Waist omphalion	0.58
10th rib left	Waist omphalion	0.71
10th rib right	Waist omphalion	0.72
Waist preferred	ASIS left	0.72
Waist preferred	ASIS right	0.74
Cervicale -40	Waist omphalion	0.74
Waist omphalion	ASIS left	0.75
Waist omphalion	ASIS right	0.76

**Table L-15. Influential Changes from Session 5 to 6.**

From	To	Ratio
Substernale	Waist preferred	1.20
Bustpoint left	10th rib left	1.14
Bustpoint right	10th rib right	1.16
Waist preferred	Waist omphalion	0.63
Waist preferred	ASIS left	0.69
Waist preferred	ASIS right	0.68
10th rib left	Waist omphalion	0.70
10th rib right	Waist omphalion	0.69
Waist omphalion	ASIS left	0.71
Waist omphalion	ASIS right	0.69
Cervicale -40	Waist omphalion	0.70
Cervicale -40	Waist preferred	0.73
Cervicale -30	Waist omphalion	0.77
Cervicale -30	Waist preferred	0.83
Cervicale -20	Waist omphalion	0.82
Cervicale -20	Waist preferred	0.89
Cervicale -10	Waist omphalion	0.86
Cervicale	Waist omphalion	0.88

### Influential Changes from Session 5 to 6.

From	To	Ratio
PSIS left	Waist omphalion	0.72
PSIS right	Waist omphalion	0.72
PSIS left	Waist preferred	0.75
PSIS right	Waist preferred	0.75
10th rib left	ASIS right	0.83
10th rib right	ASIS right	0.77
10th rib left	ASIS left	0.79
10th rib right	ASIS left	0.85
10th rib left	Waist preferred	0.80
10th rib right	Waist preferred	0.79
Substernale	Waist omphalion	0.81
PSIS left	10th rib left	0.83
PSIS right	10th rib left	0.86
PSIS left	10th rib right	0.87
PSIS right	10th rib right	0.84
Bustpoint left	Waist omphalion	0.84
Bustpoint right	Waist omphalion	0.84
ASIS left	ASIS right	0.84
Cervicale -40	10th rib left	0.84
Cervicale -40	10th rib right	0.85
Suprasternale	Waist omphalion	0.88
Substernale	ASIS left	0.90
Substernale	ASIS right	0.88
Bustpoint left	ASIS right	0.89
Bustpoint right	ASIS right	0.88
Bustpoint left	ASIS left	0.90
Bustpoint right	ASIS left	0.92
Cervicale -40	ASIS left	0.90
Cervicale -40	ASIS right	0.89
PSIS left	ASIS left	0.90
PSIS right	ASIS right	0.91

## **Appendix M: Subject Session Record**

**Table M-1. Subject Session Record.**

Subject	Session	Target Date	Session completed	Weeks pregnant
1	1	baseline session	20-Dec-96	9 weeks
	2			
	3			
	4			
	5			
	6			
2	1	baseline session	17-Jan-97	4 weeks
	2	20 weeks	30-Apr-97	19 weeks
	3	28-29 weeks	30-Jun-97	28 weeks
	4	32-33 weeks	28-Jul-97	32 weeks
	5	37-38 weeks	27-Aug-97	37 weeks
	6	Post-delivery	30-Sept-97	3 weeks
3	1	baseline session	21-Jan-97	9 weeks
	2	20 weeks	7-May-97	24 weeks
	3	28-29 weeks	10-Jun-97	29 weeks
	4	32-33 weeks	2-Jul-97	32 weeks
	5	37-38 weeks	7-Aug-97	37 weeks
	6	Post-delivery	25-Sept-97	5 weeks
4	1	baseline session	22-Jan-97	16 weeks
	2	20 weeks	19-Feb-97	20 weeks
	3	28-29 weeks	scanner down	scanner down
	4	32-33 weeks	14-May-97	32 weeks
	5	37-38 weeks	23-Jun-97	38 weeks
	6	Post-delivery	10-Jul-97	2 weeks
5	1	baseline session	24-Jan-97	9 weeks
	2	20 weeks	9-Apr-97	20 weeks
	3			
	4			
	5			
	6			

Subject	Session	Target Date	Session completed	Weeks pregnant
6	1	baseline session	25-Jan-97	12 weeks
	2	20 weeks	8-Mar-97	18 weeks
	3	28-29 weeks	31-May	30 weeks
	4	32-33 weeks	21-Jun-97	33 weeks
	5	37-38 weeks	24-Jul-97	38 weeks
	6	Post-delivery	20-Aug-97	2.5 weeks
7	1	baseline session	27-Jan-97	10 weeks
	2	20 weeks	1-May-97	23 weeks
	3	28-29 weeks	13-Jun-97	29 weeks
	4	32-33 weeks	10-Jul-97	33 weeks
	5	37-38 weeks	7-Aug-97	37 weeks
	6	Post-delivery	30-Sept-97	3.5 weeks
8	1	baseline session	29-Jan-97	8 weeks
	2	20 weeks	1-May-97	21 weeks
	3	28-29 weeks	20-Jun-97	28 weeks
	4	32-33 weeks	7-Jul-97	31 weeks
	5	37-38 weeks	20-Aug-97	37 weeks
	6	Post-delivery	28-Oct-97	5.5 weeks
9	1	baseline session	30-Jan-97	9 weeks
	2			
	3			
	4			
	5			
	6			
10	1	baseline session	31-Jan-97	9.5 weeks
	2	20 weeks	8-May-97	23 weeks
	3	28-29 weeks	6-Jun-97	28 weeks
	4	32-33 weeks	10-Jul-97	33 weeks
	5	37-38 weeks	8-Aug-97	37 weeks
	6	Post-delivery	24-Sept-97	2 weeks



Subject	Session	Target Date	Session completed	Weeks pregnant
11	1	baseline session	31-Jan-97	9 weeks
	2	20 weeks	1-May-97	22 weeks
	3	28-29 weeks	13-Jun-97	28 weeks
	4	32-33 weeks	10-Jul-97	32 weeks
	5	37-38 weeks	13-Aug-97	37 weeks
	6	Post-delivery	7-Oct-97	4.5 weeks
12	1	baseline session	4-Feb-97	13 weeks
	2	20 weeks	27-Mar-97	20 weeks
	3	28-29 weeks	20-May-97	28 weeks
	4			
	5			
	6			
13	1	baseline session	5-Feb-97	14 weeks
	2	20 weeks	19-Mar-97	20 weeks
	3	28-29 weeks	19-May-97	28 weeks
	4			
	5			
	6			
14	1	baseline session	5-Feb-97	8 weeks
	2			
	3			
	4			
	5			
	6			
15	1	baseline session	7-Feb-97	8 weeks
	2	20 weeks	7-May-97	20 weeks
	3	28-29 weeks	1-Jul-97	28 weeks
	4	32-33 weeks	1-Aug-97	33 weeks
	5	37-38 weeks	2-Sept-97	37 weeks
	6	Post-delivery	23-Oct-97	5.5 weeks

Subject	Session	Target Date	Session completed	Weeks pregnant
16	1	baseline session	10-Feb-97	8 weeks
	2	20 weeks	2-May-97	20 weeks
	3	28-29 weeks	23-Jun-97	28 weeks
	4	32-33 weeks	31-Jul-97	33 weeks
	5	37-38 weeks	missed (in labor)	missed (in labor)
	6	Post-delivery	1-Oct-97	4 weeks
17	1	baseline session	11-Feb-97	7 weeks
	2	20 weeks	27-May-97	22 weeks
	3	28-29 weeks	7-Jul-97	28 weeks
	4	32-33 weeks	8-Aug-97	32 weeks
	5	37-38 weeks	10-Sept-97	37 weeks
	6	Post-delivery	4-Nov-97	3 weeks
18	1	baseline session	11-Feb-97	12 weeks
	2	20 weeks	8-Apr-97	20 weeks
	3	28-29 weeks	11-Jun-97	29 weeks
	4			
	5			
	6			
19	1	baseline session	13-Feb-97	6 weeks
	2	20 weeks	15-May-97	19 weeks
	3	28-29 weeks	28-Jul-97	29 weeks
	4	32-33 weeks	15-Aug-97	32 weeks
	5	37-38 weeks	23-Sept-97	37 weeks
	6	Post-delivery	22-Oct-97	3 weeks
20	1	baseline session	18-Feb-97	9 weeks
	2	20 weeks	23-May-97	22 weeks
	3	28-29 weeks	on vacation	on vacation
	4	32-33 weeks	29-Jul-97	32 weeks
	5			
	6			

Subject	Session	Target Date	Session completed	Weeks pregnant
21	1	baseline session	21-Feb-97	9 weeks
	2	20 weeks	21-May-97	22 weeks
	3	28-29 weeks	25-Jul-97	31 weeks
	4	32-33 weeks	20-Aug-97	35 weeks
	5	37-38 weeks	missed (in labor)	missed (in labor)
	6	Post-delivery	23-Oct-97	5 weeks
22	1	baseline session	25-Feb-97	6 weeks
	2	20 weeks	2-Jun-97	20 weeks
	3	28-29 weeks	30-Jul-97	28 weeks
	4	32-33 weeks	27-Aug-97	32 weeks
	5	37-38 weeks	29-Sept-97	37 weeks
	6	Post-delivery	13-Nov-97	3 weeks
23	1	baseline session	28-Feb-97	5 weeks
	2			
	3			
	4			
	5			
	6			
24	1	baseline session	6-Mar-97	6 weeks
	2	20 weeks	12-Jun-97	20 weeks
	3	28-29 weeks	11-Aug-97	28 weeks
	4	32-33 weeks	4-Sept-97	32 weeks
	5	37-38 weeks	9-Oct-97	37 weeks
	6	Post-delivery	8-Dec-97	8.5 weeks
25	1	baseline session	10-Mar-97	7 weeks
	2			
	3			
	4			
	5			
	6			

Subject	Session	Target Date	Session completed	Weeks pregnant
26	1	baseline session	11-Mar-97	9 weeks
	2			
	3			
	4			
	5			
	6			
27	1	baseline session	13-Mar-97	9 weeks
	2	20 weeks	9-Jun-97	21 weeks
	3	28-29 weeks	31-Jul-97	29 weeks
	4	32-33 weeks	28-Aug-97	33 weeks
	5			
	6			
28	1	baseline session	14-Mar-97	6 weeks
	2	20 weeks	27-Jun-97	21 weeks
	3	28-29 weeks	13-Aug-97	28 weeks
	4	32-33 weeks	18-Sept-97	33 weeks
	5	37-38 weeks	30-Oct-97	39 weeks
	6	Post-delivery	4-Dec-97	2 weeks
29	1	baseline session	1-Apr-97	9 weeks
	2			
	3			
	4			
	5			
	6			
30	1	baseline session	22-Apr-97	7 weeks
	2	20 weeks	25-Jul-97	20 weeks
	3	28-29 weeks	12-Sept-97	27 weeks
	4	32-33 weeks	16-Oct-97	32 weeks
	5	37-38 weeks	20-Nov-97	37 weeks
	6	Post-delivery	18-Dec-97	3 weeks

Subject	Session	Target Date	Session completed	Weeks pregnant
31	1	baseline session	28-Apr-97	7 weeks
	2			
	3			
	4			
	5			
	6			
32	1	baseline session	29-Apr-97	12 weeks
	2	20 weeks	7-Jul-97	22 weeks
	3	28-29 weeks	19-Aug-97	28 weeks
	4	32-33 weeks	18-Sept-97	32 weeks
	5	37-38 weeks	24-Oct-97	37 weeks
	6	Post-delivery	25-Nov-97	2 weeks
33	1	baseline session	30-Apr-97	10 weeks
	2	20 weeks	2-Jul-97	20 weeks
	3	28-29 weeks	3-Sept-97	28 weeks
	4	32-33 weeks	25-Sept-97	32 weeks
	5	37-38 weeks	5-Nov-97	38 weeks
	6			
34	1	baseline session	17-May-97	10 weeks
	2			
	3			
	4			
	5			
	6			
35	1	baseline session	22-May-97	6 weeks
	2			
	3			
	4			
	5			
	6			